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HER ROYAL HIGHNESS LA INFANTA DOÑA EULALIA DE BORBON,

REPRESENTATIVE OF HER MAJESTY THE QUEEN REGENT OF SPAIN, AT THE WORLD'S COLUMBIAN EXPOSITION.

THE WORLD'S COLUMBIAN EXPOSITION.

IF we consider the distances which separate the locality of our great Exposition from European countries—in round numbers, three thousand miles of water and one thousand miles of land—we have reason to be gratified at the interest which foreign nations have taken in the grand affair. Not only have they contributed many important and valuable objects to enhance the attractions of the exhibition, but many prominent personages, representing various governments, have undertaken the sea voyages and landed on our shores, to share in the work itself. Particularly gratifying has been the presence of the Duke of Veragua, from Spain, the lineal descendant of Columbus, and Her Royal Highness, the Princess Eulalia, representing the throne of Spain and the successors of Queen Isabella. Many brilliant festivities have taken place in honor of this royal lady, whose cordial ways and words in acknowledging these expressions of welcome have touched the popular heart. She has been everywhere received with the greatest enthusiasm. We present upon our first page her portrait, for which we are indebted to *La Ilustracion*, of Madrid.

In evidence of the foreign interest to which we have alluded, we reproduce from *L'Illustration*, Paris, and *The Graphic*, London, a number of engravings of the various buildings with descriptions. The following is from our Paris contemporary.

"We propose to-day to give a brief description of the principal palaces of this great exhibition, which extends not only over Jackson Park with its 500 acres, but which borrows about 325 supplementary acres from Washington Park, without counting the tongue of land which connects this extent with the Midway Plaisance. In reality, the area of the Columbian Exhibition is five times greater than that of the Paris Exposition of 1889, which, including the Trocadero, the Invalides and the wharves, did not comprise 200 acres.

"The principal buildings and palaces constructed upon this immense extent along Lake Michigan, which is larger than the Black Sea, are as follows:

"1. *The Palace of Manufactures and Liberal Arts*, which occupies a space of about 30 acres. Its form is rectangular, and the central hall is covered with a glass roof 260 feet in height, and is surrounded by two circular galleries each more than 3,000 feet in length.

"The inhabitants of Chicago state with pride that this palace is twice as large as St. Peter's at Rome, and three times as vast as the Colisseum, which was not capable of containing more than 80,000 spectators, while 150,000 might move about in this edifice of Corinthian style.

"The architect of this gigantic structure, which, according to the statistics of which the Americans make abuse, might afford storage room for all the stones of the largest of the Egyptian pyramids, is Mr. George B. Post, of New York. It does great honor to his genius. Its details are in excellent taste.

"2. *The Women's Palace*, constructed in the style of the Italian Renaissance, is exclusively reserved for the beautiful sex. The architect is Miss Sophie Hayden, a pupil of the Boston School of Technology. It is 400 feet in length. The lagoon opposite this palace forms a bay nearly 430 feet in width, in the center of which a landing has been constructed whose stairway leads to a terrace 6½ feet above the level of the water. Everything that belongs to the realm of the woman of the present epoch, as well as of prehistoric ages, will be gathered together in this palace, toilet, cuisine, minor female productions, domestic arts, labor and charitable organizations, female clubs—in short, nothing that can illustrate the charm, grace, devotion and practical mind of woman has been forgotten.

"3. *The Palace of Fisheries* consists of a large central building with polygonal pavilions of true originality in the Spanish Roman style. The roof, as well as a portion of the wall, is covered with gilded tiling, in the *ensemble* of which there is nothing excessive or glaring. This edifice will contain the most surprising aquariums in the world.

"4. *The Palace of Agriculture.*—A wonderful palace in the classical Renaissance style, situated near the level of the lagoons, which, from the lake, lead to the park. The structure is 800 feet in length by 500 feet in width. At the facade fronting upon the lake rise the heroic columns, symbolizing the thirteen original States of the Union. The building has but one story, and this gives not only picturesqueness, but also great boldness to the architecture. The cornice line is about 60 feet above the stairway. On each side of the main entrances there are Corinthian pillars 50 feet in height and 5 feet in diameter. The area of the central pavilion is 400 square feet. A vestibule 70 feet in length leads to a rotunda surmounted by a glass dome of 130 feet elevation, and in which are remarked numerous statues emblematical of agriculture. A monumental staircase gives access to a meeting hall easily capable of seating 15,000 persons.

"5. *The Palace of Horticulture* ends at Midway Plaisance. Its facade faces a little lake or lagoon, from which a simple balustrade of flowers separates it. This building is over 300 feet in length and over 250 feet in width. Its central pavilion is like an immense bell glass. It is flanked by two monumental pavilions, which are of an elegant and very free Florentine style. In this palace there will always be free air floral exhibitions, and numerous basins will be reserved for Nymphæas and all other kinds of aquatic plants.

"6. *The Palace of Fine Arts*, which stands at the northern part of the park, is likewise architecturally charming. Although constructed in the Ionian style, Mr. Atwood, the architect, has been able to give it the stamp of rare contemporaneous originality. It is about 600 by 300 feet, and consists of a large nave and a transept that intersect each other at the center, where there is a dome 115 feet in diameter by 138 feet in height. Sculpture will occupy the ground floor. The pictures and *bass-reliefs* will, as is customary, be relegated to various galleries upon the walls of the nave and transept. Two annex pavilions, situated to the right and left of the central pavilion, with which they are connected by galleries, will be set apart for various artistic exhibits that will not have found a place in the industrial sections, properly so called.

"7. *The Palace of Mines* is constructed in the French style. One of its facades fronts the south and the other the north, upon the lake. Both are ornamented with sculptures and attributes relative to the various industries connected with mining. More than 1,500,000 pounds of iron have entered into this structure, which, in the interior, is provided with vast staircases leading to galleries 60 feet in width.

"8. *The Palace of Electricity* is 750 feet in length by 375 feet in width. It is formed of Corinthian pillars 45 feet in height and 3¾ feet in diameter. The entablature that they support is light and of charming harmony. At the four corners of the building stand pavilions of the nature of the acropolises of Greece, dominated by a tower 138 feet in height. Opposite the main entrance stands a colossal statue of Benjamin Franklin, while over the secondary doors are read the names of the principal propagators of electricity.

"9. *The Government Palace*, constructed of materials from the State of Washington, covers a space of ground of 155 feet by 240 feet, and gives a curious idea of the strange architecture of this young and powerful country. In addition to private contributions, the government has spent $52,000 for the elaboration of the plans and construction of this palace. Moreover, for the collections of its exhibition, it has furnished more than twenty thousand dollars. The mast that surmounts the central pavilion is 190 feet in height.

"10. *The Transportation Palace* stands at the southwest extremity of Jackson Park, between the Mines and Agricultural buildings. A huge arch designates the entrance of it. Its facade is simple and of wide proportions. Secondary entrances, preceded by terraces and statues, give its profile the aspect of an ultra-modern temple. The palace measures 960 feet by 250 feet. In this exhibition will be found a complete history of human locomotion, from the baby carriage up to the most elegant cars and the most extraordinary carriages. The locomotives that have been used from time to time will figure in these extensive halls, as will also balloons and the various modes of correspondence by carrier pigeons.

"11. *The Administration Palace* will be no less successful than the preceding. The Americans consider it the pearl of this sort of architectural competition. It covers but a small space, but its exterior is of such a decorative elegance that it may be considered as one of the most remarkable masterpieces of modern construction inspired by the French Renaissance. In the corner pavilions have been already installed the offices of the administration and those of the police and firemen, and the bank and the restaurants. A statue of Columbus stands at the entrance.

"12. *The Machinery Palace*, constructed after plans by Messrs. Peabody & Stearns, of Boston, is not conceived in the style of the vast Crystal Palace of the Paris Exposition of 1889. It comprises three naves so ingeniously combined that it is hoped to utilize it in the future for railway depots. The motive power necessary for the machines exhibited is derived from a special building situated at one of the sides of the edifice. Upon the principal facade it is the Spanish Renaissance that triumphs. The whole edifice is covered with colored 'staff,' giving it a brilliant and luxuriant appearance to the eye.

"These twelve palaces, here too briefly described, constitute the first-class edifices of the Chicago Exhibition; but, along with these sumptuous structures, Jackson Park will show more than twenty colossal buildings which alone would excite admiration in exhibitions less phenomenal than this."

BIRD'S EYE VIEW OF THE WORLD'S COLUMBIAN EXPOSITION—LOOKING WEST.

The following is from *The Graphic*, London:

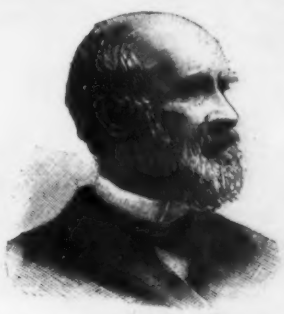
THE CHICAGO EXHIBITION.

"The success of the French Centennial Exhibition of 1889 seems to have inspired the Americans who crowded the Champ de Mars on that occasion in large numbers with the idea of holding an exhibition of their own which should surpass the Paris Exhibition in size and comprehensiveness, and should in general 'go one better.' And as the date of the discovery of the New World by Columbus was within a year or two of its four hundredth anniversary, there was an obvious

reason for holding an exhibition in America. Columbus left Spain in August, 1492, and in the October following landed at the Bahama Islands, and later on in Cuba; but he did not touch the mainland of the continent until six years later, when Cabot had already set foot on its shore. When considering the dates, the earlier period was chosen: as to have put off the exhibition to 1897 or 1898 would have been to miss the advantage of the impulse given by the French Exhibition.

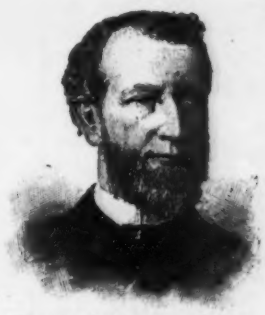
"The great question that presented itself was the choice of a city in which to hold the Exhibition, and New York, Washington, Philadelphia, St. Louis, Cincinnati, and Chicago all competed for the honor of furnishing the site. However, it was soon evident that the choice lay between New York and Chicago, and at first it seemed likely that New York would have it all its own way. Nevertheless, Chicago set to work with the greatest energy, organized a committee, guaranteed large funds, sent commissioners to Paris to study the working of exhibitions, and came to Washington fully prepared to argue its case on all points. On the other hand, New York was divided against itself, and the internal feuds which took the place of united action caused it to lose the day; so on April 25, 1890, an Act of Congress was passed deciding that the Exhibition celebrating the four hundredth anniversary of the discovery of America by Columbus should be held at Chicago, and making the undertaking a government affair. The date of the Exhibition was, however, altered from 1892 to 1893, in order to give time for the preparations necessary to success.

COL. GEORGE R. DAVIS,
Director-General of the Chicago Exhibition.

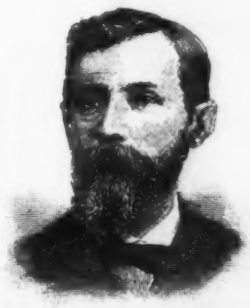


MR. THOMAS R. BRYAN,
First Vice-President of the Directors of the Exhibition and Board of Administration.

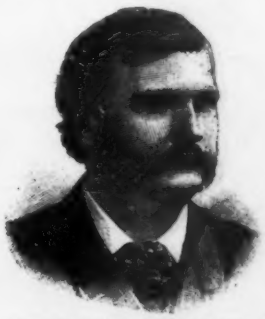
HON. LYMAN J. GAGE,
President of the Chicago Exhibition.



MR. ANTHONY F. SEEBERGER,
Treasurer to the Directors.



MR. HARLOW N. HIGINBOTHAM,
President of the Chicago Exhibition and Board of Administration.



MR. BENJAMIN BUTTERWORTH,
Secretary to the Directors.

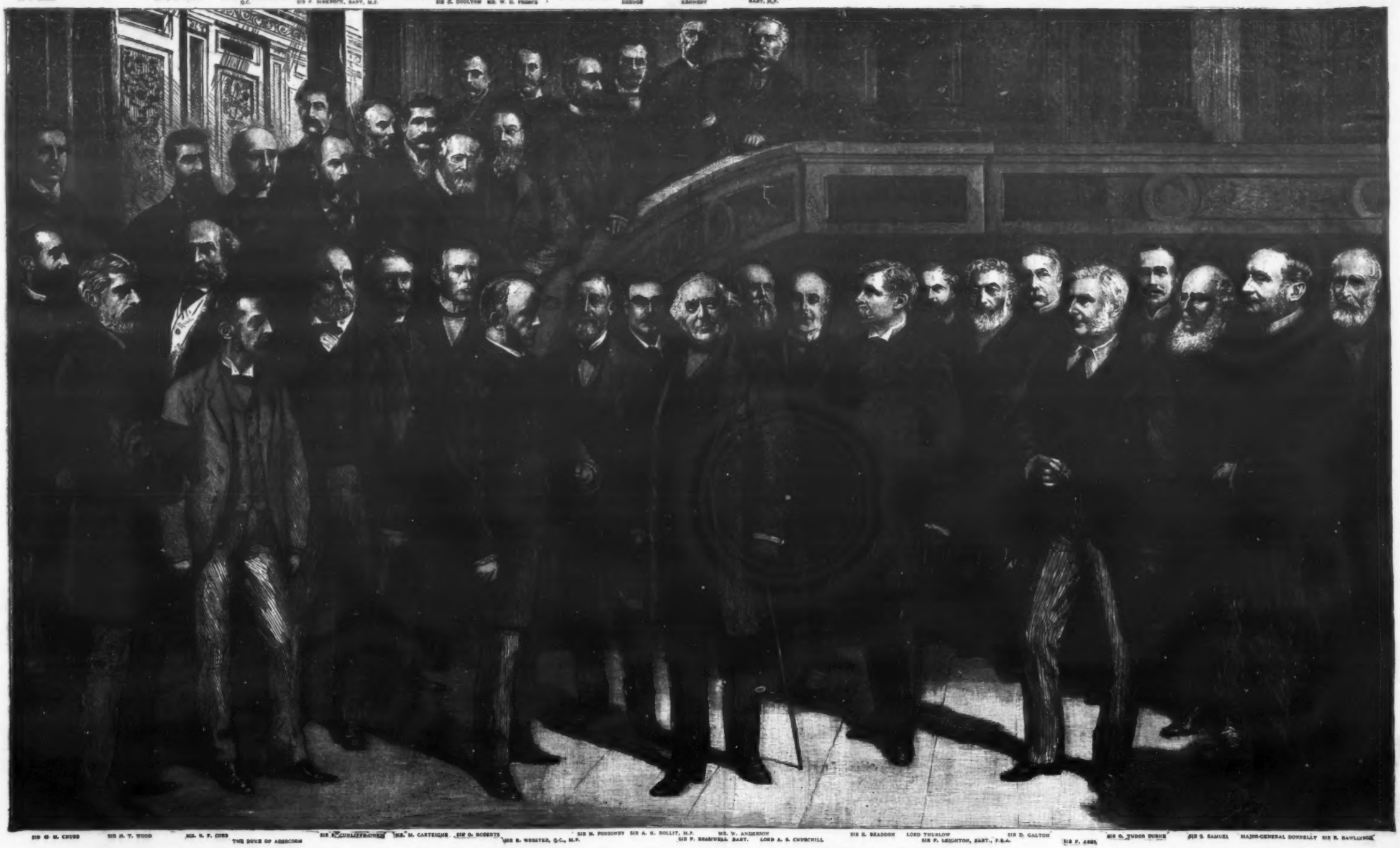
HON. THOMAS W. PALMER,
President of the Exhibition Commission.

MRS. BERTHA HONORE PALMER,
President of the Board of Lady Managers.

THE UNITED STATES COMMISSION.

"The general control of the Exhibition was vested in a United States Commission formed of two Commissioners from each State and Territory, and of eight special members, but the actual carrying out of the details, and the responsibility for the proper organization, fell to the Executive Committee, which consists entirely of citizens of Chicago, who represent the guarantors of the city of Chicago, and are responsible for the minimum sum of ten millions of dollars, and for the various unforeseen expenses which must necessarily be incurred. The enthusiasm of the citizens of Chicago soon raised the money required, and then began the battle of the sites, in which most public bodies and all the newspapers in the city took an active part. Chicago is known as the garden city from the number of its parks, and each and every site found enthusiastic supporters of its claims. Finally it was decided to occupy Jackson Park, which contains 586 acres; Washington Park, which is about a mile distant and contains 371 acres; and a strip of 80 acres connecting the two parks, and known as the Midway Plaisance. Of the 1,037 acres thus available for the Exhibition, Jackson Park and the Midway Plaisance are used for the buildings and grounds, as the park lies along Lake Michigan, and had only partly been laid out by the city authorities. Washington Park has already been laid out with fine plantations of trees and broad lawns, and is to be used for separate pavilions, flower shows, and such like. The site of the Exhibition is about seven miles from the center of Chicago, but the means of transport are so abundant that this presents no difficulties, and hotels and boarding houses have been built close to the grounds for the accommodation of guests. The site itself is a magnificent one, and combines lake frontage and parkland

THE WORLD'S COLUMBIAN EXPOSITION—THE PALACE OF MACHINERY.



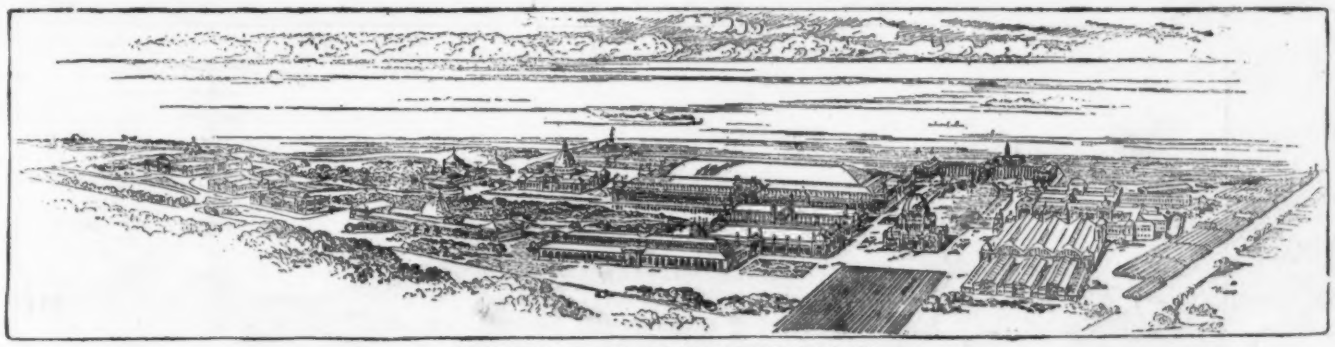
THE ROYAL COMMISSION FOR THE WORLD'S COLUMBIAN EXPOSITION, 1893.

MEMBERS OF THE COUNCIL OF THE SOCIETY FOR THE ENCOURAGEMENT OF ARTS, MANUFACTURES, AND COMMERCE, AUTHORIZED BY HER MAJESTY TO ACT AS A ROYAL COMMISSION FOR THE CHICAGO EXHIBITION.

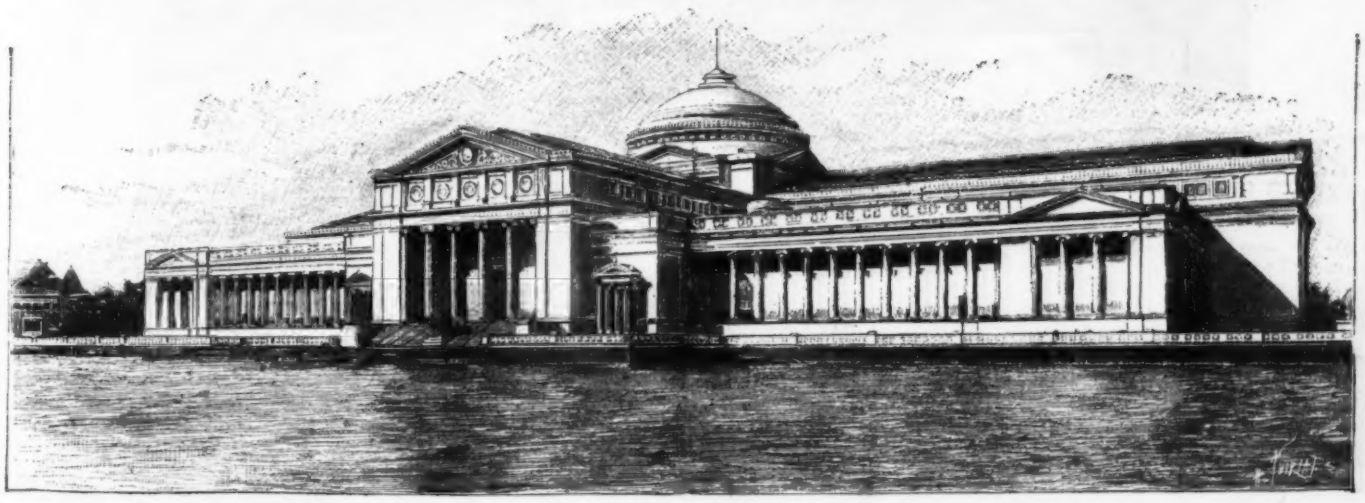
in a degree that makes it specially suited for the purpose.

THE CITY OF CHICAGO.

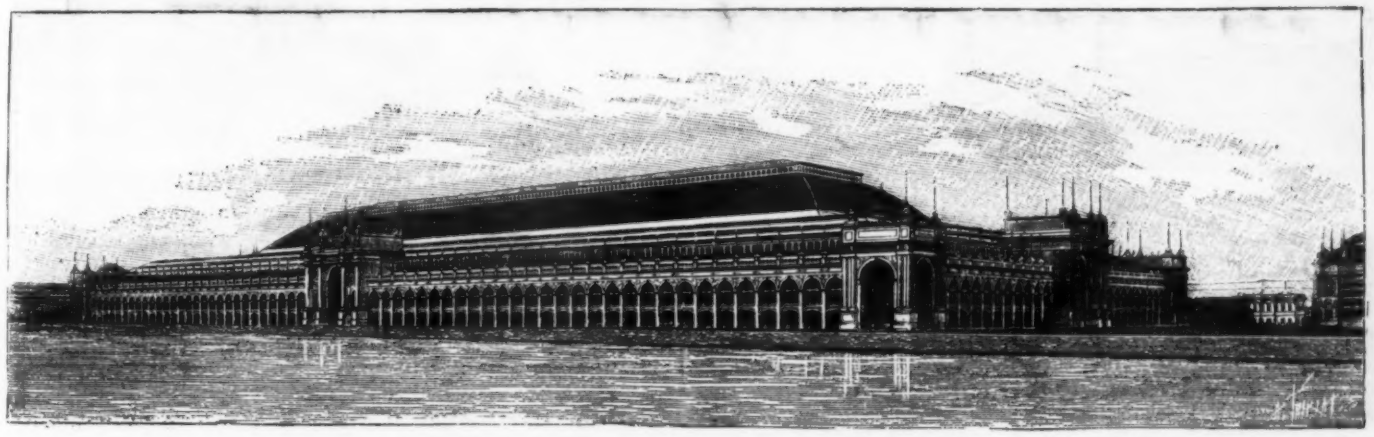
"Though Chicago is now the second city, in point of size, in the States, its history really only dates from 1804, when it was a millitary outpost on the frontier, always exposed to attacks from hostile Indians. Little more than a century ago it was nothing but swampy marshland, with the Chicago river flowing sluggishly into the lake. Joliet, a Frenchman from Louisiana, first explored the district in 1673, but for many years malaria and the fear of the Indians kept settlers away. In 1804 a small fort was built where Chicago now stands, to counteract the English influence at the north of the lake, and round the fort a few fur traders and trappers and backwoodsmen clustered for protection. In 1812 the fort was destroyed and the garrison and settlers massacred, but in 1814 the fort was rebuilt and a village grew rapidly round it. But the real founders of Chicago were the Illinois and Michigan Canal Commissioners, who had been given power by the United States government to lay out towns on the land granted to them. In 1830 they drew out plans for the new town, and in 1832 the first business building was erected in the place. In 1833 the population numbered 350, but by 1837 its population had risen to 4,170



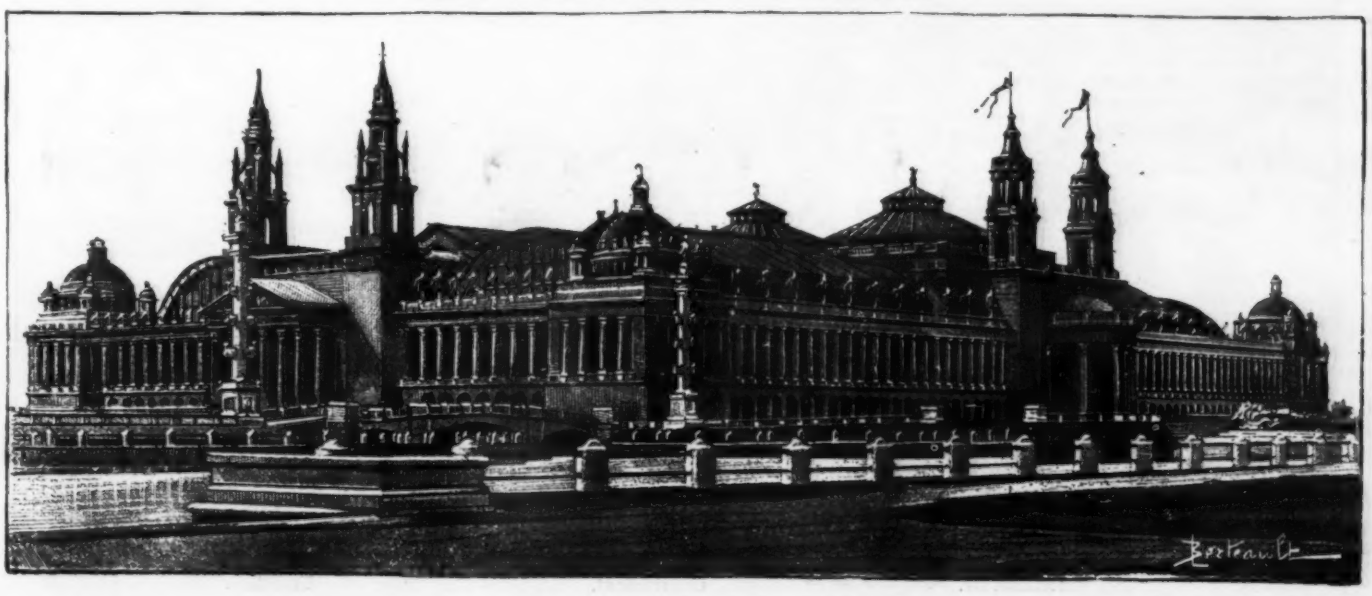
GENERAL VIEW OF THE EXPOSITION.



PALACE OF THE FINE ARTS.



PALACE OF MANUFACTURES AND LIBERAL ARTS.



PALACE OF MACHINERY.

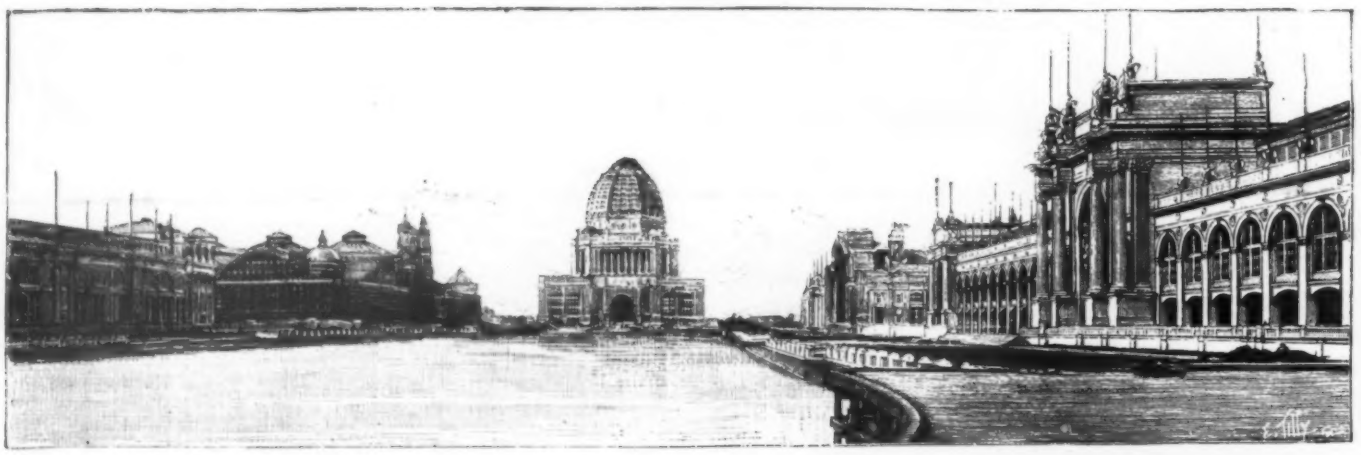
THE WORLD'S COLUMBIAN EXPOSITION.

persons, and they got their town raised to the dignity of a city. In 1870 the old city was burned down, but in ten years from that time all traces of the disaster had been obliterated, the city had been rebuilt with finer buildings, and now Chicago covers 180 square miles, has a population of nearly 1,300,000, and is the trading metropolis of the center and west of America.

THE BRITISH COMMISSION.

"The idea of a Chicago Exhibition—or, as it is phrased in the quaint American dialect, 'The World's Columbian Exposition'—was at first received in this country with contempt mingled with resentment at the hostile tariff of which Mr. McKinley was the author; but now England and her colonies have determined to exhibit, and an area of about five hundred thousand square feet has been allotted to Great Britain and the British possessions within the Exhibition buildings. The formal application asking that Great Britain should take part in the Chicago Exhibition was made on behalf of the United States Government in March, 1891, by Mr. Lincoln, who was then Minister in London, and Lord Salisbury replied that a Royal Commission would be appointed for the purpose. One or two bodies were approached by Her Majesty's Government, and in June, 1891, Sir James Ferguson, then Under-Secretary of State for Foreign Affairs, applied to the Society of Arts, through Sir Richard Webster, its chairman of the council, to know whether the society would undertake the organization of a British

PALACE OF TRANSPORTATION.



MACHINERY. ADMINISTRATION. MANUFACTURES.

Horticulture. Government. Fine Arts.

THE LAGOON—VIEW FROM THE NORTH.

THE WORLD'S COLUMBIAN EXPOSITION.

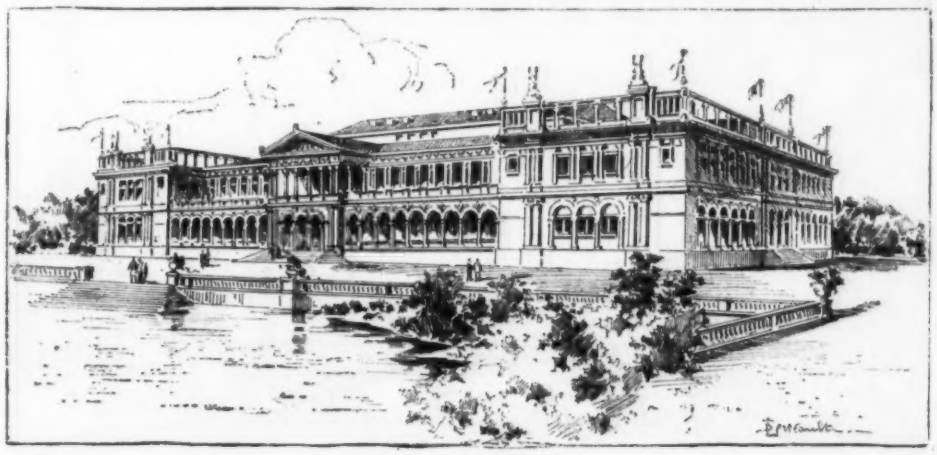
section at Chicago if a sum of 25,000*l.* were set aside by the Treasury for that purpose. This the Society of Arts agreed to do, provided that a charge proportional to the space occupied should be made to exhibitors, in order to supplement the government grant, as had been done at the Paris Exhibition of 1889. On August 26, 1891, Her Majesty issued a commission under her sign manual, appointing the Council of the Society of Arts for the time being a Royal Commission for the purpose of organizing the British section at Chicago. The Prince of Wales is president, and Sir Richard Webster and Sir Frederick Bramwell are the vice-presidents of the society and of the commission, of which the Duke of Edinburgh and other distinguished men are also members, Sir Henry Trueman Wood, secretary, and Mr. H. B. Wheatley and Mr. E. H. Lloyd, assistant secretaries.

GREAT BRITAIN AND THE BRITISH POSSESSIONS.

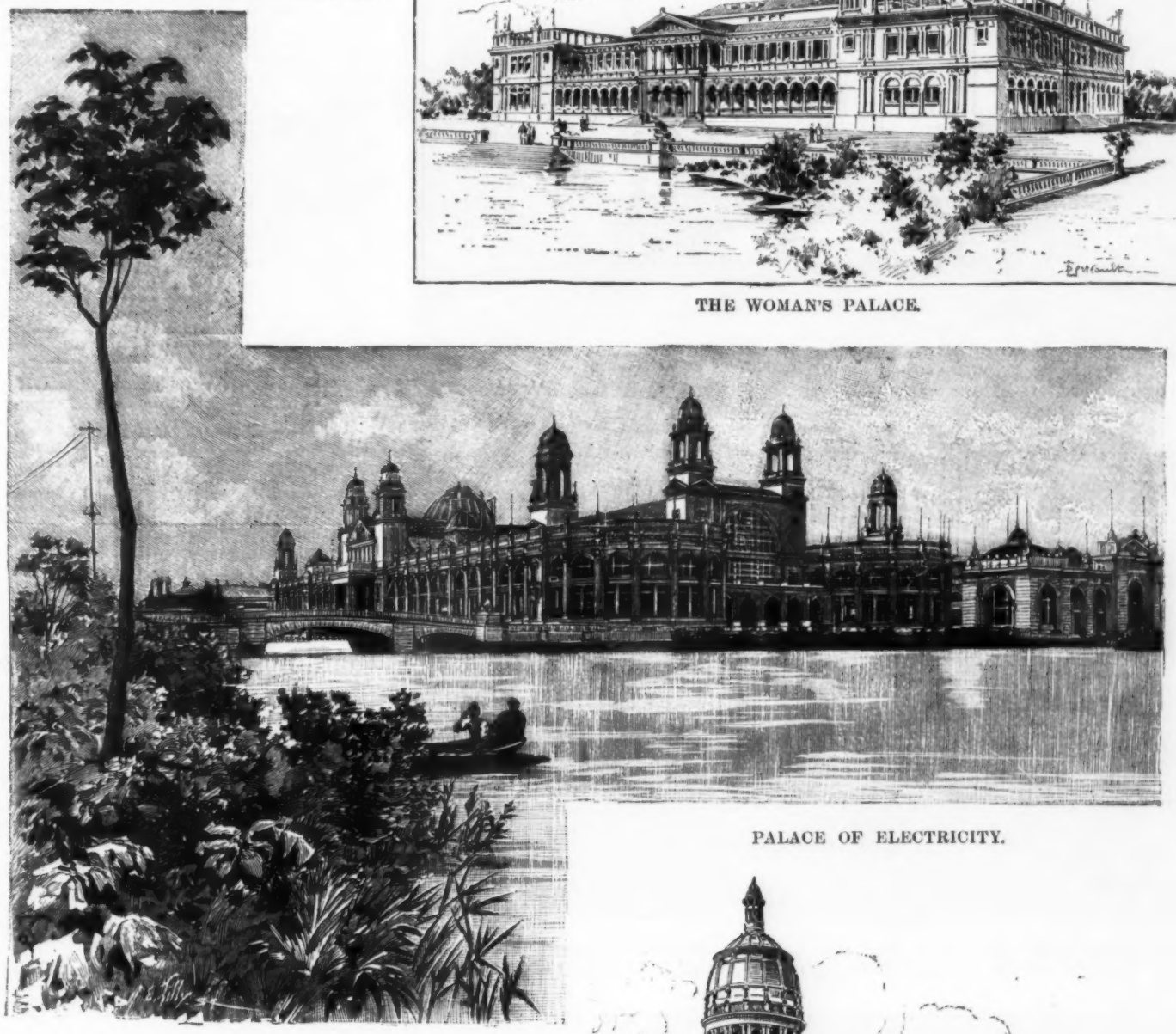
"However, when the proposition was made, the Government of India did not seem inclined to take any part in the Exhibition, but eventually it decided to prepare and send a small collection of Indian forest products, and to make a grant of 40,000 rupees to the Indian Tea Association, as well as a grant of 10,000 rupees to Messrs. Tellery, of Delhi, to enable them to send a representative collection of Indian art ware. As for the Colonies, Canada at once decided to participate, but from Australia only New South Wales decided to appoint a commission, though Victoria, Queensland, and Tasmania all had the matter under consideration. The Cape Colony nominated a commissioner, and Ceylon, British Guiana, Jamaica, and Trinidad are also represented at Chicago. Several other colonies at first decided to take part in the Exhibition, but afterward withdrew. The total space allotted to the Colonies is about 190,000 square feet, and to India a little less than 5,000 square feet. As soon as they could obtain the information from the American Executive, the Society of Arts sent circulars to the principal British manufacturers who had taken part in former international exhibitions, as well as to all those who had much trade with the States, and they also inserted advertisements in English, Scotch, and Irish newspapers, with the result that a large number of applications for space were received. A good deal of interest was also aroused in the Exhibition itself, and consequently the commission felt itself justified in urging upon the Chancellor of the Exchequer the necessity of placing a large sum at its disposal if Great Britain was to hold its own among the other nations, all of whom were making far greater preparations for exhibiting. This requisition was very strongly supported, and in April, 1892, the Chancellor of the Exchequer announced that the grant to the Royal Commission would be increased from 25,000*l.* to 60,000*l.* on the condition that no charge should be made for space to British exhibitors. The total area allotted to Great Britain and the British possessions is about five hundred thousand square feet, the mother country occupying about three-fifths of that space. The most important exhibits are those in the sections devoted to manufactures, the liberal arts, transportation, and machinery, but in fine arts Great Britain is also well represented.

THE VICTORIA HOUSE.

"The offices of the commission are in the grounds of Jackson Park, and her Majesty has graciously permitted the building which contains them to be called the Victoria House. Colonel Edis, who is the honorary architect to the commission, is the designer of the house, and in the general plan has followed the style of the half-timbered houses of the Tudor period. The lower story is faced with red brick and has mullioned windows, and terra-cotta is also largely employed, while the upper story is half-timbered and has the projecting gables characteristic of the sixteenth century. The house forms three sides of a quadrangle, the open side being toward the lake, and inclosed with a raised terrace and balustrade. Steps lead up from both sides in front to a covered portico, which opens into the central hall. On one side of the hall are the offices and on the other a library and the reception rooms. On the first floor there are rooms for the commission and more offices. The interior of the Victoria House has been most elaborately decorated, and the wall panels and the ceilings have been copied from some of the most noteworthy examples in old English country houses. The house is most picturesquely situated on the shores of Lake Michigan, opposite the naval exhibit of the United States, and close to all the principal galleries and buildings.



THE WOMAN'S PALACE.



PALACE OF ELECTRICITY.

GOVERNMENT.

THE OPENING CEREMONY.

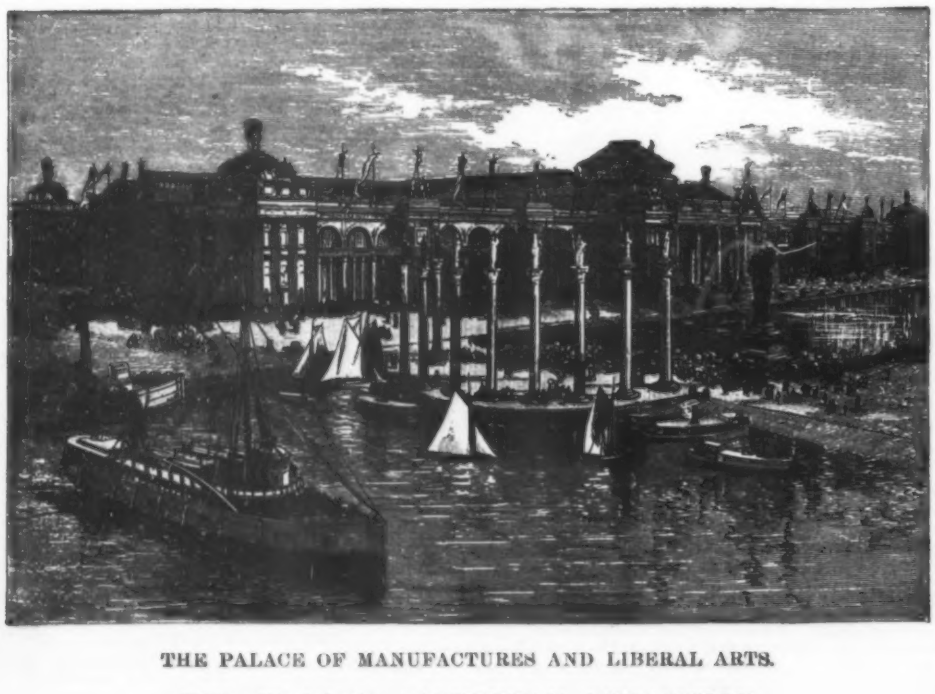
"The Exhibition was opened on Monday, May 1, 1893, by President Cleveland in dull weather. The President's procession started from Lexington Hotel at nine o'clock in the morning, and Mr. Cleveland was

THE WORLD'S COLUMBIAN EXPOSITION.

accompanied by Vice-President Stevenson, Mr. Gresham, Mr. Carlisle, the Duke and Duchess of Veragua (the descendants of Columbus), the Governor of Illinois, the Mayor of Chicago and others. The platform on which the inaugural ceremonies took place was in the Administration building, and as the company took their places a band of six hundred performers played the Columbian march and hymn. Prayers were offered, and a poem based on the voyage of Columbus was read. Then Mr. G. R. Davis, director-general of the Exhibition, delivered an address reviewing the work accomplished. When the President rose to open the Exhibition he was received with enthusiastic cheering, and after a speech in praise of the United States touched a button which started all the machinery of the Exhibition. The fountains began to play, the artillery fired salutes, the bells rang, and all the flags on the buildings were simultaneously unfurled on the stroke of noon. A grand luncheon followed, at which the Duke of Veragua sat at the President's right hand as the guest of honor."

THE LAGOON AND THE FRONTS OF THE ELECTRICITY AND MANUFACTURES BUILDINGS AND BRIDGES.

THE PALACE OF MANUFACTURES AND LIBERAL ARTS, THE LARGEST COVERED AREA IN THE WORLD, THE ROOF COVERING ABOUT 30½ ACRES.



THE PALACE OF MANUFACTURES AND LIBERAL ARTS.

THE WORLD'S COLUMBIAN EXPOSITION.

The following is from *Engineering*, London:

"There are two streets of main buildings. On the front, or wider one, are the pavilions of Nebraska, Dakota, Minnesota, Louisiana, Missouri, Pennsylvania, New York, Massachusetts, and Maine; in the back street are a number of others, not, perhaps, so imposing in appearance. Of the foreign pavilions those of Germany and Sweden are the most conspicuous, though the French building, which will be a reproduction of the Petit Trianon, will be very beautiful. The Swedish building is, we believe, the reproduction of some historic structure, and is sufficiently capacious to receive the whole of the Swedish contributions to the Fair. The German pavilion is not only by far the most important and beautiful of all the separate buildings, but we think it is the one which will attract the greatest amount of interest on the part of visitors, whether they are drawn merely by curiosity or by intelligent appreciation. The building is a vast one; its exterior is an adaptation of some of the old house architecture for which Nuremberg is famous, and the gayly colored tiles of the high-pitched roofs, together with the slender and decorative spires and turrets, from which the scaffolding is not yet removed, make the German pavilion a conspicuous object in the landscape. We shall take an early opportunity of describing this building in considerable detail; it is sufficient for the present to say that within the principal features are a great hall in which will be displayed the overflow of Germany's liberal arts collection, and the reproduction of a chapel for the reception of ecclesiastical exhibits. We have condensed this reference to the State and foreign buildings into a few lines, but a mere casual examination of the score of structures erected on what will be a most attractive part of the Exhibition would be a work of some hours. Later on, when all is completed, days can be profitably devoted to a study of the contents of the various buildings.

"Beyond the buildings just mentioned, and standing quite alone, facing the lake, is the suburban villa designed by Mr. Edis to do duty as the headquarters of the British Commission.

"Close by the British building, in the waters of the lake, is the model United States ironclad Illinois, so perfect a reproduction that it is difficult to believe that one of the famous White Squadron has not found its way through the canals and lakes to Jackson Park. On board, too, but for the immobility of the decks, it is difficult to believe one is not on board a man-of-war, although it is true that many things are shown here that have never before been shown afloat. From the small jetty that protects the ironclad upon one side, the foreshore of the lake stretches away with a long and even curve. The destructive waters of Lake Michigan are prevented from injuring this frontage by a wide pitched slope, surmounted by a broad and level paved sidewalk and carriage-way. This promenade is of a much earlier date than the Exhibition scheme, of which it has worked in to be a very useful feature. To the right stretches the long arched colonnade of the Manufactures building, and in the hazy distance are the beautiful outlines of the Casino and the Agricultural building, which stands on the other side of the great basin in the central court. In the foreground, but further removed from the lake, is the United States Government building, of warmer hues as to its walls and reddened dome and roofs. This latter building is the nearest to the model ship, and passing through its great arched central entrance we find every promise of practical readiness, or rather an appearance of readiness, for the 1st of May. Most of the exhibits of the War Department—a section in charge of Major Comly—are on the ground; the greater number of them are in place. Conspicuous are the exhibits of ordnance, the largest object being the 60 ton gun recently completed at the Watervliet Arsenal. Some of this part of the exhibit is out of doors in front of the building—chiefly a range of large caliber mortars. Army equipments and accouterments are exhibited in great numbers, shown to the best advantage on dummy horses and men, and a thousand objects connected with every branch of the service are here, but we have not time to examine them. We are forced, however, to throw a passing glance of admiration upon the very beautiful diorama of the Greely Arctic Expedition, a model picture beautifully rendered, which will always command a large crowd of exhibitors. From this department we pass into the great central rotunda, fully complete except for some finishing touches of decoration, and leaving on one side the various departments of the State which are represented in different parts of the building, we enter that of the Smithsonian Institution, which is a combination of the South Kensington and the Natural History Museum. We have only time to remark the cases of stuffed animals and model figures now being skillfully arranged by Dr. Goode, whose name will be so pleasantly remembered by all those who had to do with the Fisheries Exhibition in London. Dr. Goode has now quitted the Fisheries Department to fill other important functions at the Smithsonian Institution, and he has just now to find time from his arduous Exhibition work to consider the important question of exhibitors' awards, which, as we shall see later on, are to be decided by a novel and entirely untried method worked out by Mr. J. B. Thacher, Chairman of Awards.

THE PALACE OF MANUFACTURES.

"A stretch of what will be, later on, green turf, and a broad roadway, separate the Government building from the Manufactures hall, the largest covered building in existence. The great central roof of this building, 386 feet in width and 200 feet high, is a marvel of lightness and bold engineering design. It is, with most of the other ironwork on the Exhibition grounds, the work of Mr. Shankland, who has built up the professional reputation of a lifetime during the last two years. It may be interesting to mention that when the contract was offered to the Edgemoor Bridge Works, whose president is Mr. William Sellers, of Philadelphia, it was determined to decline the responsibility because it was considered that the proportions

adopted were dangerously light. A careful discussion with Mr. Shankland, however, modified this opinion, and the terrible storms that have swept over the building during the last winter have fully justified the work. So far as one can judge at present, the vast height of this building will not dwarf the exhibits in the manner which we anticipated would have been the case.

"The peculiar methods of installation adopted by most countries may partly account for this. This method consists in the construction of great courts or pavilions for the exhibits of each country, these structures being of monumental proportions to suit the dimensions of the building. In the center, at the point of intersection of the longitudinal and transverse avenues, there rises far away toward the roof a lofty and ornate clock tower; this object is conspicuous throughout the building, and will doubtless be a place of rendezvous for millions during the next six months. This clock tower is in the center of a great *rond point*, upon the four quadrants of which face the courts of the United States, of England, Germany and France. With the exception of England, all these countries occupying this position of honor announce their location by bold and beautiful decorative treatment, the inclosing screens rising high in the air, although dominated by the central clock tower. Down the central avenues run the longer sides of these various courts, each treated in its own peculiar fashion. Varying entirely in design, the facades of these courts have one feature in common, that of great height and elaborate and rich detail. England is here again the exception, no effort having been made to construct anything like an inclosing pavilion, and, indeed, without a much larger money grant, this would have been impossible. Consequently the architectural facades of the French and Belgian courts, behind which are arranged the cases of their exhibitors, look down upon the British frontage, dwarfing the handsome show cases in which the best of the British goods are displayed. They are handsome show cases for the most part, and contain, it is satisfactory to notice, ceramic and other exhibits of which the country may be proud; but as there has not been the slightest attempt at uniformity, either in design or color, the greatest possible contrast with the symmetrical pavilions on the other side of the avenue is presented. We are glad to notice the state of forwardness in the British court, although there is every indication that the exhibits of both France and Germany will be in equally good order on the opening day, and it would appear as if the American exhibitors will be much less advanced than those of foreign countries.

"On either side of the great hall are the three smaller spans that surround the main central building. The effect of this part of the hall is somewhat disappointing and dark, on account of the upper galleries, placed 25 feet above the ground line; but, of course, this additional floor space was absolutely necessary to provide for the many exhibitors who had to be accommodated. Indeed, in the German court the pressure has been so great that they have been compelled to erect a second gallery above the first over a large part of the space. In the upper galleries, which of themselves are extensive enough to afford shelter to the industrial exhibits of an average exhibition, the work of progress is advancing very rapidly. Special attention cannot fail to be attracted by the extremely artistic and original show cases and small pavilions in the American section, both on the ground floor and on the gallery; they compare favorably with the very best efforts of France and Germany. England does not enter into comparison; indeed, we should believe it will be found that the pavilions of Tiffany and a few other leading American exhibitors will be more beautiful than anything that France or Germany can offer.

"Returning to the gallery, it will be seen that in the British section quite an effective display of color has been obtained by flag draperies and banners hung overhead. These latter have been lent by a number of corporations of cities and boroughs, and by at least twenty of the City companies. The French section adjoining in the same gallery is being arranged with consummate taste and skill, and will, we think, when completed, be one of the most effective portions in the building. The space is divided out into large rooms by light timber partitions, over which dark red cotton fabric is strained, and overhead the structure of the building is concealed by a ceiling of thin white muslin. The cases placed in these rooms are uniform in design and color (black and gold), and the whole scheme of arrangement has been carried out according to one plan, the individual exhibitor having had to conform to the rules laid down. It is only by walking to and fro in this vast building that one can judge of its size by the feeling of fatigue.

"On the opposite side of the grand basin are the extremely beautiful facades of the Agricultural and Machinery buildings. Our readers are familiar with the outlines of these as well as of all the other buildings upon the ground, but engravings fail to give any idea of their size, beauty, and grandeur, and it is worth the journey from London to Chicago only to stand upon this vast terrace and see what America has been able to accomplish in the way of exhibition buildings within the space of twenty months.

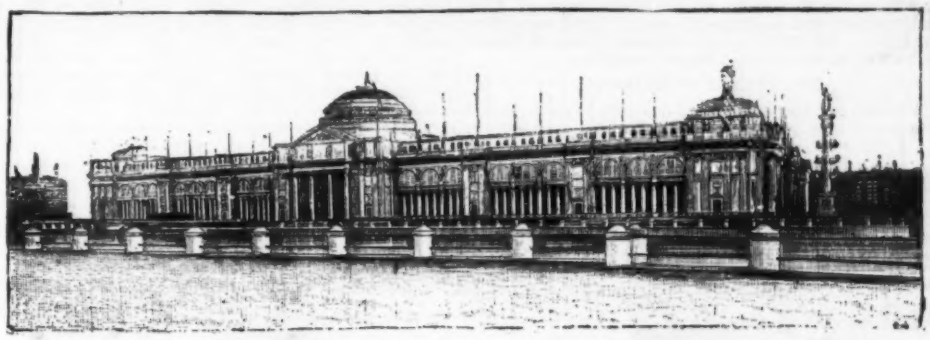
"At the head of the grand basin stands the monumental MacMonnies fountain, surrounded by a shallow circular basin, and flanked by smaller basins on each side; it is here will be concentrated the great display of illuminated fountains. The visitor will notice that the floor, as well as the sides of the basin in which the fountain stands, are of wood, the sides being concealed by ornamental staffwork, and the floor covered with painted canvas.

THE PALACE OF ELECTRICITY.

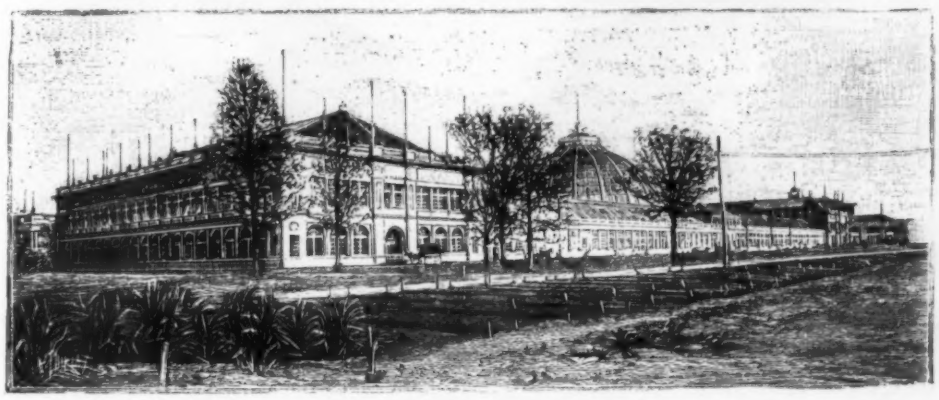
"The Electricity building lies to the right hand of the Manufactures hall, and as we enter through the great central portal—with difficulty, owing to the press of wagons and the prevailing mud—we are struck by the fine proportions of the very light arched roof, which, with the corresponding transept, forms the main features of the building. The square courts on each side of these two principal galleries are somewhat low, and are covered with flat roofs, and we were prepared for a somewhat unsatisfactory effect in this part of the building.

"Indications are not wanting of the grandest display of electrical engineering that has ever been got together. The Westinghouse Electrical Manufacturing Company will, among other things, show ten dynamos, each of a capacity of 15,000 lights. They each weigh 75 tons, and are 18 ft. in height. Fifteen hundred horse power will be required to drive these machines. The collective lighting efficiency of the dynamos exhibited by the General Electric Lighting Company will be 16,000 lamps with 1,600 horse power. The General Telephone Company has erected a very fine and large pavilion, in which apparatus will be displayed and telephonic demonstrations given.

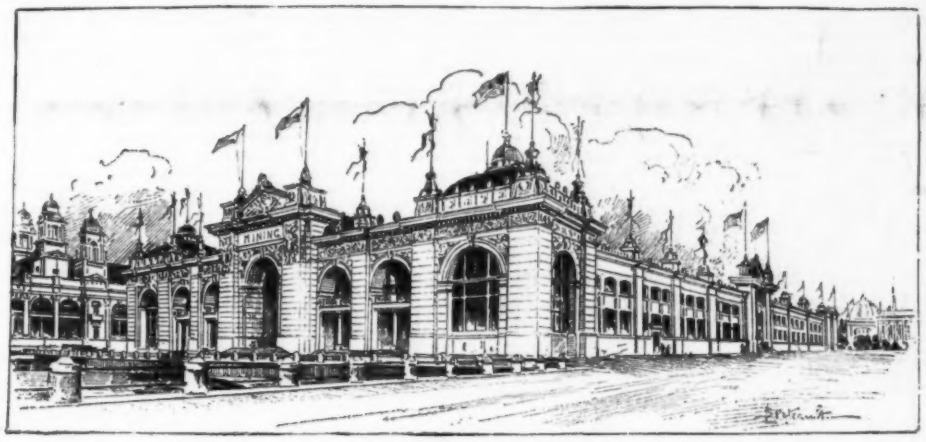
"England is conspicuous by her absence, and Germany, as usual, is erecting a monumental pavilion surrounding the large space into which she is crowding her numerous exhibits. Among these the most con-



PALACE OF AGRICULTURE.



PALACE OF HORTICULTURE.



PALACE OF MINES.

ADMINISTRATION PALACE.

THE WORLD'S COLUMBIAN EXPOSITION.

spicuous will probably be that of MM. Schukert & Co., of Nuremberg. This enterprising firm, among other things, will exhibit seven search lights and projectors completely equipped; the largest of these projectors will be 6 ft. in diameter and will be fitted with an arc lamp of 60,000 candles. As befitting its purpose, the electric light will reign supreme within this building. Besides the display made by private exhibitors, which will, of course, be considerable, the building will be illuminated by 436 arc lights, each of 2,000 candle power, and in addition about 20,000 incandescent lights. The effect of this brilliant flood of illumination will be somewhat difficult to realize.

THE PALACE OF MINING.

"Passing out through one of the exits in the rounded bays that give a peculiarly characteristic appearance

M. KRANZ, COMMISSIONER-GENERAL FOR FRANCE.

M. ROGER-BALLU, FINE ARTS COMMISSIONER-GENERAL FOR FRANCE.

to the north end of the Electricity building, we turn toward the adjacent Mines and Mining hall, but before doing so we pause to notice the grouping of the buildings around it in the distance. On the right-hand side is the omnipresent Manufactures building; immediately in front stretches the lagoon and Wooded Island, connected with the mainland by numerous bridges; to the left the Transportation Exhibit building, now somewhat gayly colored, but which is to be transformed into ivory-white and cream within the next few days, at a cost of some 5,000*l*. The present color certainly clashes with the delicate tones of the surrounding buildings, and the Golden Gate, which forms the principal feature of this building, will be thrown into far better relief when the change has been made. Beyond lies, also on the left, the great Horticultural building, with its vast central dome; and in front, still further in the distance, the Illinois State building, which, as it should do, takes precedence, both in position and in size, of all the other State buildings on the ground. A broad road separates the Electricity and Mining buildings, a hard and durable carriage road. Wondering at the rapidity with which this conversion, and miles of similar ones on the Exhibition grounds, have been made in such a brief time, we enter the Mines and Mining building. This is the structure covered by the bold cantilever roof of Mr. Beman, with the arrangement of which our readers are familiar. The effect of this roof is very satisfactory, and it would be difficult to conceive a structure better adapted to exhibition purposes. Under Mr. Skiff's energetic management matters have advanced rapidly. A wide aisle runs down the center of this building, flanked on either side by the pavilions of many countries, all of them elegantly designed, and some magnificent. The clear passageway of the central aisle is broken at two points by obelisks reaching to a height of 60 ft. from the ground. One of these is intended to give an idea of the famous mammoth seam in the anthracite coal deposits of Pennsylvania. It consists of blocks of coal reared against a timber core, the coal being cut from the seam of the height of the obelisk, representing its full thickness.

"The other monument, which is only just commenced, is the embodiment of the ingenious idea of Mr. Skiff; it represents the mineral products of the United States for each second of time, according to the last published statistics. The base of this very original column consists of a large block of coal; other blocks of iron, copper, lead, gold, silver, and other ores will be reared upon it; samples of building stones will be added, and so will the finished metallurgical products of the United States, the whole finishing with a capping of the precious metals.

"Starting from the southern entrance of the building, we see on the left-hand side the great inclosure devoted to Mexico. There is nothing striking about the preparations for this exhibit, which will be contained principally in cabinets, and will represent nearly all the mineral wealth already known in the country. Opposite is the court of Montana, inclosed by ranges of columns standing on a continuous base, and supporting a sculptured frieze; the materials of which this court is composed are like those of all the others from the State to which they refer.

"Very large and ornate are the corresponding courts of Idaho, California, Wisconsin, Missouri, and Michigan; there is evidently a great deal of rivalry between these States, each seeking to produce the most attractive and elaborate pavilion in stone and marble, and in one case even of coal. On the left-hand side of the aisle, adjoining the space assigned to Mexico, comes the pavilion of Brazil, large in dimensions, and costly and elaborate in design.

THE GERMAN METALLURGICAL EXHIBIT.

"Adjoining it is the great metallurgical trophy of Germany, on which the exhibitors have spent some thousands of pounds and several months of labor. Such a trophy has probably never been seen in the United States; the Paris Exhibition of 1889, it will be remembered, had many of these wonderful combinations of metallurgical products. The trophy is flanked on each side by two tall and slender pyramids of rolled beams, cut into short lengths, and built up with the heaviest sections at the base and the lightest at the top. Between them in the center is a sort of architectural device, some 50 ft. in height, constructed out of pipes, straight, curved, and bent, complete or cut through the center, as the exigencies of the design command. Immediately behind this is an elaborate group of figures, representing metallurgical industry, cast in bronze, and supported on each side by two elegant and lofty trophies of rails, bars, and wire. The back of this structure is composed of other examples of manufactured iron and steel.

"Immediately in the center of the court, facing this great trophy, as well as two of the American pavilions on the other side, stands the shed which has been constructed by Messrs. Johnson, Matthey & Co. for the display of their platinum manufactures.

"England has but eleven exhibitors in this important building, and we are glad to notice that the Lowmoor Company has an effective though very small exhibit. Two of our possessions, Ontario and New South Wales, make amends for the almost absolute indifference of the mother country; their courts are large, and will be crowded with examples of their mineral resources, and the display of New South Wales will especially be attractive and of interest. Beyond, near the north end, Switzerland and Germany occupy the remaining space.

THE PALACE OF TRANSPORTATION.

"Probably the building which will occupy hereafter the most of our attention is that devoted to transportation exhibits, interpreted in the most general and wide sense, and thus including a great number of objects whose connection with transportation requires no little imagination to realize. It is to this building that is affiliated the famous Krupp pavilion, which cost the Essen firm some £300,000, including the contents, transportation, and insurance. It will be remembered that the Transportation building comprises three long straight galleries, each about 100 feet, and each covered by a separate roof; an upper gallery runs round the building, affording a large well lighted space for lighter objects. Besides the main structure there is a vast annex of shedding; it is here that space is found for the famous exhibit of the Baltimore and Ohio Railroad Company, and here on numerous railway tracks will be placed long ranges of locomotives, cars, and other rolling stock, chiefly, of course, by American exhibitors. Annexed to this building is the building of the Pennsylvania Railroad Company, consisting of the reproduction of one of their small passenger stations completely equipped, while by the platform are laid lengths of the standard track, each rail being 100 feet long. Here will be fitted a complete example of the signaling apparatus of the railway. As in all the other buildings, England has been assigned a post of honor, and we are glad to say that here at all events our space is fairly filled with good exhibits, to say nothing of the magnificent locomotive from the London and Northwestern Railway, the historic "Lord of the Isles" of the Great Western, the monumental Winby engine, and other railway plant. The most valuable part of the British section in this building is to be found, however, in the fine collection of ship and marine engine models sent by nearly all the principal shipbuilders and transport lines. To a large extent the success of this collection is due to the efforts of Dr. Elgar and Captain Hoff. In the upper gallery is a fair show of bicycles and other objects illustrating transportation. But if we have done fairly well in this building, Germany again takes the lead, for she occupies no less than 104,000 square feet, as compared with our 54,000; in fact, her space in this building is more than we occupy in the Manufactures hall. A great part of the German space in the upper gallery is devoted to the display of relief models of waterways and harbors, and it may be mentioned here in passing that America, France, and Holland all contribute splendid examples of this kind. Much surprise will also be felt at the splendid display of German ship models, which are quite numerous and of very beautiful execution. The ground floor is closely occupied with a great number of collective and other exhibits, to which we shall refer in detail in due time.

"We have only time now to glance at two conspicuous objects in the building. The first of these is a full sized reproduction, for a length of 80 feet, and running from keel to funnel, of one of the great new passenger steamers being built by Messrs. Cramp & Co., of Philadelphia, for the American Line, and which are intended to surpass in speed and luxury the latest additions to the Cunard fleet. As the interior of this reproduction is accessible to the public, and as the section is fully equipped in every detail, some idea of the size and magnificence of the modern Atlantic steamer will be given to the population of the Middle States who have never seen the sea. The second object towers up nearly to the roof of the second gallery of the Transportation building; it is a reproduction of the large and greatest power hammer erected by the Bethlehem Iron Company, for forging the armor plates for the new war vessels of the United States."

J. D.

PALACE OF FISHERIES.

THE WORLD'S COLUMBIAN EXPOSITION.

THE NEW HYDROGEN MINER'S SAFETY LAMP.

By Professor F. CLOWES, D.Sc., etc.

(*Abstract.*)

AT a recent meeting of the Society of Chemical Industry, London, Professor Clowes showed the compact and portable form which his hydrogen oil safety lamp has recently assumed, and illustrated by means of diagrams and lantern slides the very delicate and accurate results which the lamp yielded in detecting and measuring small percentages of fire damp, coal gas, water gas, and petroleum vapor in the air by means of the "flame cap." The lamp presented the advantage of perfect safety in air containing any proportion of inflammable gas or vapor; it further served as a good illuminator, as an ordinary rough indicator of "gas" by means of its full or reduced oil flame, and as a most accurate and delicate indicator and measurer by means of its standard hydrogen flame.

The hydrogen supply for the lamp was carried in the pocket in a small steel cylinder. The gas was compressed in this cylinder under about 100 atmospheres, and this supply furnished the standard 10 millimeter hydrogen flame burning continuously for about 40 minutes. This would serve for about 80 separate tests. When the hydrogen flame was required, the cylinder could be instantaneously attached to the lamp, and when the gas was turned on it furnished a supply to a jet beside the lamp flame, which at once kindled it. The ordinary lamp flame was extinguished during the

test, and was rekindled from the hydrogen flame after the test had been completed. The hydrogen flame was then extinguished and the cylinder detached.

The hydrogen flame had long been acknowledged to be the flame best adapted to accurate and delicate gas testing, but it was now for the first time brought into practical use, and the author was the first to carefully measure and tabulate its indications.

It will be readily understood that the main advantages resulting from the use of the hydrogen flame are the following:

1. The flame is non-luminous, whatever its dimensions may be, and therefore does not interfere with the perception of the cap.

2. The flame can always be adjusted at once to a standard height and maintained at that height sufficiently long for the completion of the test; whereas other testing flames are constantly varying in dimensions, and most of them cannot be set to standard size at all with any certainty.

Thus a colza-petroleum flame exposed in air containing a low percentage of gas when twice adjusted gave caps of 8 and of 20 mm. The reduced oil flame often fell so quickly that cap readings with low percentages of gas could not be taken at all.

3. The caps produced over the hydrogen flame are larger than those produced by any flame of corresponding size.

4. The size of the hydrogen flame can therefore be so far reduced as to enable it to be used in an ordinary safety lamp.

The size of the flame may further be suitably varied so as to increase or decrease the height of the cap, and thus either increase the delicacy of the test or extend its range.

5. The hydrogen flame shows no trace of mantle or cap in air free from gas; it resembles the Pieler flame in showing only a slender thread above its apex. The colza-petroleum and the benzoline flames show pale mantles in gas-free air, which may be easily mistaken for a small percentage of gas.

6. The standard hydrogen flame burns vigorously, it is of fair size, and therefore cannot be extinguished by accident; whereas the reduced flames ordinarily used in testing burn feebly and are readily lost.

7. Hydrogen is supplied pure and of practically invariable composition; whereas oil and alcohol are apt to vary much in composition, and therefore to give flames whose indications vary with the sample of liquid which is being burnt.

The hydrogen oil lamp has been found by use in the coal mine to be thoroughly practical. Its indications are not interfered with by the coal dust usually present in the air of the mine. Those used to testing for gas in the ordinary way adopt it with little, if any, previous training.

SKIM MILK FOR MANUFACTURING PURPOSES.

J. CARTER BELL, A.R.S., M.I.C.

MANY will think that skim milk has very little to do with manufacturing chemistry, or the scientific chemist, but my attention has been called to it in connection with the Rivers Pollution Act. A large firm of cheese makers, in Shropshire, were in the habit of sending all the whey and skim milk which could not be used for their pigs into the nearest river, and I was applied to for information as to the best means of utilizing these waste products.

Two methods have presented themselves to me, the first being an invention for making all kinds of buttons, door knobs, electric lighting furniture, umbrella handles and many sundry small things from lactite, a substance made from skim milk.

In this process the milk is heated to 85° or 88° F., and to every 58 gallons is added about 4 oz. of rennet. As soon as the milk is coagulated the curds are washed once in warm water and then put into a masticator, which is warmed to about 150° F.

In the masticator should be placed about 2½ lb. of borax, with about 4 pints of skim milk. When the masticator has been run for a short time until the curd is almost converted into a solid mass, about 2 lb. of starch (arrowroot is preferred) are made into a paste with some of the milk or whey, and 3 oz. of alum are also added, and the whole mass well incorporated.

The masticator is run for about one hour, and at the end of this time 3 lb. of acetate of lead dissolved in half a gallon of acetic acid are added to the mass, and carefully worked in; when the mixings have been well made the mass is taken to the hydro-extractor, and then put into a hot press with a daily change of cloths, until it is properly set; it is then dried in the air and made up into the various articles you see before you.

A large factory was fitted up near Manchester for the manufacture of lactite, but I am informed that up to the present time it has not been a financial success, for the articles which have been made, such as buttons, etc., when sewn on to clothes, have the unpleasant property of readily breaking in pieces on the slightest touch, or often on none at all; so I cannot see how lactite buttons, handles, etc., can compete with the time-honored and well tried bone articles. Still there are cases when the skim milk has to be thrown away; at such times it may be profitable to make lactite, and it may be an industry for the British farmer, who is at present sorely tried with severe competition. This lactite, when well prepared, will well keep for any length of time.

The second process, which I have been experimenting with, is to convert the skim milk or whey into a portable article of food; for since, as is well known, it is impossible to send skim milk or whey at a profit to distant towns, some simple process by which the farmers could get rid of the water at a small cost and leave a residue rich in nitrogenous matter is a thing very much to be desired. The specimens which I place before you have been made from skim milk and whey. The name given to this new compound is lactoserin. This is prepared in a variety of ways as food for man, cattle and poultry:

No. 1 is dry curds, not ground.

No. 2, the same, but ground to fine powder.

No. 3, serin. This consists chiefly of milk sugar from the evaporated whey.

No. 4, lactoserin, which consists of one-third of skim milk, two-thirds whey.

No. 5, double lactoserin, half skim milk, half wney.

No. 6, brown roasted lactoserin, for mixing with cocoa instead of starch. I have not had time to make analyses of all these preparations, but I think it will be sufficient if I give one the mean of several analyses:

DOUBLE LACTOSERIN.

Water	3·32
Protein matters	22·56
Fat	1·34
Carbohydrates	66·13
Ash	6·99

The manufacture of these products ought to possess great interest for the English farmer, for it will enable him to turn to marketable value what has too often been a waste product. This manufacture of dry curds and serin can be carried on at small places as well as large, but I need not say that it would be more economical to work 1,000 gallons than 100.

The dry curds are obtained from the skim milk in quite the same way as in the production of cheese, by putting rennet into it. The curds are pressed and ground and then dried in a drying oven.

It has been estimated that the manufacture of the dry curds will not cost more than about one farthing a gallon for the skim milk used.

The serin is manufactured by evaporating skim milk and whey together in different proportions for different purposes. For this purpose a special evaporating vessel is required which will hold about 250 gallons; this costs in Sweden (where the process is being worked) 55*l.*, and a machine for the stirring up the mass as it is cooling down. This apparatus will cost 10*l.* for the size corresponding to the 250 gallons. The expense in Sweden is only one farthing a gallon, therefore the cheapness and simplicity of the process ought to recommend itself to the attention of our agriculturists at home.—*Jour. Soc. Chem. Industry.*

In connection with the foregoing, we subjoin the following abstract from the United States patent granted to Linbomir R. Mestaniz, of Brooklyn, N. Y., No. 353,697, dated December 7, 1886, for making artificial bone, ebony, marble, etc. Application filed November 17, 1883: A new and useful improvement in the making of a..ificial bone, ebony, marble and other substances for various purposes and devices, as articles of wear, ornaments for personal and household use and also in the arts and applied sciences.

Heretofore in Europe and in this country the domestic or common pot cheese has been treated with chemical agents, principally sal soda and acetic acid, for the purpose of extracting from the caseine an adhesive matter, which serves as a glue, and with the property of being insoluble in water. Mixed with plaster or lime it acts as cement in the mending of statuary or for the making of a durable article for other uses. If colored, it will produce imitation agate, coral, etc. Frequently, however, it happens that the materials first combined to effect a glutinous mass are spoiled and rendered worthless for the reason that sal soda, if used in sufficient quantity to remove the butyraceous and other substances to be removed from the cheese solution, renders the resulting mass too brittle for available use. Other failures are caused in the use of the acid, owing to its variable strength, either in too small or large a quantity, and so by inexpert handling losing or overstepping the exact period of agglutination. Besides, the process is expensive because of the waste afore indicated, but principally in the high cost of the material employed.

The object of my invention is in the main fourfold: first, the promotion of greater economy in manufacture, avoiding loss occasioned by the modes of manipulation, some of which are stated above; second, the indication of a method insuring successful results; third, the use of materials whose prime cost is low; and fourth, the obtaining of products of different degrees of hardness and colors, even to the purest white, and thus of the widest range of adaptation for largely variant ends.

Having stated such object in general terms, I now proceed to give in detail the successive processes by which it is attained.

First. I take ordinary skimmed milk, and to free this from every trace of oleaginous matter I mix it with about one-third its volume of water and then cast in sufficient salt (chloride of sodium) to cover the bottom of the vessel containing the mixed milk and water for about or less than one-sixteenth of an inch; or the salt may be first sprinkled over the bottom of the vessel and the milk and water introduced by siphon or other contrivance, so as to disturb the layer of salt as little as possible I then lower the temperature of the mixture below 60° Fah. The butyraceous and other like ingredients will soon rise to the surface, to be then removed by skimming or decanting. Thereafter the residue is to be slowly passed through one or more strainers made of cotton or flannel; but the salt used should not exceed three pounds to every four hundred gallons of milk and water.

Second. The temperature of the strained fluid is then to be raised. If the ultimate end of the process is a very hard material, as of an imitation porcelain figure, the heat requisite is not to be less than 160° Fah.; but where a greater ductility will suffice it need not be above 135° Fah. When the proper degree of heat has been attained, dissolve in warm water caustic soda, using for every four hundred gallons of the fluid one-half of a pound. Strain this to free it from impurities, if the commercial sort is used, and then add it to the fluid. This must then be stirred (the motion being in one direction, ceasing near the center) for about ten minutes. The cooling process down to 100° Fah. must then be instituted, slowly if the resultant is to be pliable, and more rapidly if to be firm and resistant. If the material is likely when in use to come into contact with water, add to the fluid so brought to 100° Fah. one-half of one ounce of commercial silicate of sodium, previously mixed with water, to give it due fluidity, and duly incorporate by gentle stirring.

Third. When it is not needed that the ultimate material should be of absolute or delicate shades of white, I then add five pounds of terra alba, where medium shades of color—such as red, purple or violet—are required, less for darker, and only two pounds for an absolute black, and afterward the coloring and one-quarter of an ounce of glycerine. Stir as before, and heat up to 102° Fah. for the softer and to 105° Fah. for the harder material. If more delicate shades, as of pink, rose, etc., are sought, I add with the terra alba ten pounds of artificial or chemically prepared sulphate of baryta in pulp form; or if additional weight is no objection, a like amount of plumbum sulphuricum also in like form. If an ivory color is desired, then double at least the quantity of the last named ingredients, and add one, two or more drops of yellow aniline dissolved in alcohol, according to the exact shade wanted. When imitations of porcelain, marble and the like are to be produced, I further add seventy-five pounds of the finest white ground silica. Then the entire mass settling on the bottom of the vessel is to be scooped up by the hands or other process, so that the admixture may be even throughout.

Fourth. I then mix hydrochloric acid, commercially known as "18° Baume," and nitric acid, likewise known as "42° Baume," these being preferable, in my experience, to other grades of these acids, and only as so preferred designated of such grade. The proportions of these acids vary, according to the requisite hardness of the material and its color, from nine parts of the first to one part of the second. Of the combined acids and in the proportion needed, as is above indicated, I take about ten pounds, and for each pound of salt as used above under the first head of this description I add to the above mixture about one-half ounce of sulphuric acid and dissolve the whole in about twenty times its weight of water. This solution is to be distributed by pouring or sprinkling over the surface of the fluid, the scooping up process being continued. When the fluid becomes absolutely clear, the supply of the acid solution is discontinued. If it is seen that too much of it has been used, a small quantity of a solution of caustic soda or aqua-ammonia will correct the mistake. When the fluid is transparent, although of a green or another tint, it is then drawn off, and the remaining mass, the principal result of this process, is left to be thereafter pressed and seasoned.

Fifth. Where very delicate hues are required, a bleaching process of the milk is to be instituted after thus treated with caustic soda and while its temperature is below 100° Fah. To this end hydrochloric acid gas or chlorine evolved separately may be introduced near the bottom of the vessel, or sulphurous acid gas or any of the ordinary bleaching powders acting as not reagents on the chemicals in the solution diluted largely with water may be used. When this milk and caustic soda solution assumes a whitish shade, add the requisite coloring matter and other ingredients, as above set forth. If, while the gas or other bleaching solution introduced is working, the material commences to curl or precipitate, this may not be regarded as endangering the result, but may be allowed to continue until the fluid is clearing to a light tinted color, thereafter to be drawn off, and the residual mass to be treated as if precipitated under the previous formula, and after thorough washing mix with the coloring and earthy ingredients in accordance with the foregoing directions, except that no silicate of sodium is to be used. If it is desired to bleach the material after it has been precipitated and before any of the earthy ingredients, except silica, have been added, place the mass in a vessel filled with water and treat with the acid gases from twelve to fifteen hours, and until the water gets a purplish or other light tint or bathe it with either of the bleaching solutions above named or of sulphuric acid and salt. Let it rest for a couple of hours, draw off the fluid, wash the mass, and, while drying, incorporate thoroughly the earthy ingredients. If it is desired to bleach the material before its precipitation and after the incorporation of the earthy ingredients or of the colors, or to get a bleached bone color, the solution is to be mixed with four pints of commercial aqua-ammonia to each four hundred gallons of milk and water. Thereafter chloride of barium, one ounce to the gallon of said solution, dissolved in a large excess of water, is to be dashed over and mixed with said solution, and largely diluted sulphuric acid is to be instantaneously scattered over the precipitating mass until it becomes as white as is desired.

Sixth. Instead of using the mixture of hydrochloric and nitric acids, a weak alum solution may be employed, adding one-half ounce of glycerine. This treatment will be found preferable where that peculiar bluish-white is to be attained in imitations of porcelain and marble for statuary and like purposes, or when the product is likely to be much exposed to the action of water. To attain the desired color more satisfactorily, a few drops of aniline blue dissolved in alcohol are to be added. The precipitated mass obtained under the previous methods may also be washed with a feeble solution of alum and glycerine. For very dark shades, instead of using the mixture of hydrochloric and nitric acids, a solution of tannin, one-half pound to the said four hundred gallons, is first to be intermixed with it, and then either of said acids may be added until precipitation ensues.

Seventh. The mass is then to be pressed. I cover an iron or wooden box with apertures of moderate size in its bottom and sides with muslin or other cloth, fill it with portions of the mass, scrape the surface with a straight edge and cover with the ends of the cloth. I proceed in the filling of other boxes in this way, and as the bottom of each is beveled so that it is suited to cover the material in the box first filled, or the boxes are made of slightly different sizes, and so that the bottom of one may serve as a cover for the material in another, the boxes, when filled, are placed one over another and then under a heavy slab of iron or of wood weighted, fitted into the uppermost box, and may overhang its edges about an inch. This nest of boxes is laid up inside of a framework made air-tight by the top cover fitted as a piston, and at the bottom of the framework an air pump is adjusted. This is operated slowly, so as to remove not only the surplus moisture in the mass, but also air cells which may have been left in it. These it is of the utmost importance entirely to remove, else a ferment spreads through, disintegrates, destroys the cohesion of the mass, and renders it for large articles entirely useless. If the mass contains terra-alba, and is heated from 140° to 150° Fah., it can be passed through rollers and made into sheets of any required thinness. These sheets may then be placed in a drying room; but in most cases it is safer to separately place them in the boxes and treat as above. The cover may have an aperture in it, kept open or closed to regulate the pressure while the pump

is being worked, the air allowed to enter the aperture to be cooled and deprived of moisture by being passed over chloride of calcium or other absorbent of moisture.

Eighth. The material in mass or sheets is then, after the cloths are taken off and cut as required into various sizes, removed to the drying room. The air admitted to this room is first to pass over a series of bottles filled with sulphuric acid, quicklime and chloride of calcium. If the arrangement of the drying room does not allow the air to strike over the sulphuric acid, etc., I give the material or sheets a bath of phosphoric or sulphuric acid, wipe them off and then place them in the drying room. After remaining in it two or three days the material or sheets are then ready for final manufacture, either by turning, cutting or pressing, except that where silica is incorporated it can be only ground or pressed.

Ninth. Before the last pressing to attain the manufactured product or parts thereof commences, the material is to be softened. In cold and damp weather this is preferably to be accomplished by exposing it to hot air above 220° Fah., and in warm and dry weather by high steam. This hot air or high steam is let into an iron box in which the material, on shelves of perforated tin, has been placed. In about a half hour, according to the thickness of material, the supply of hot air or steam is cut off and the box opened, and one, with asbestos gloves or like coverings for the hands, takes out the material and puts it into moulds for final pressure into the desired shape or pattern. In cold weather the moulds may be suitably warmed. When removed from the moulds and after trimming the edges left by the outer lines of the moulds, the pieces so patterned are placed in the drying room to remain, in winter time, at least two days.

Tenth. Thereafter the polishing process commences, first in the use of tallow or castor oil for white, or of linseed or of cotton-seed oil for colored products and finishing with alcohol, or with shellac or copal dissolved in alcohol. For the darker shades a little color of the same tint may be added to the alcohol or its solutions. When a very fine and delicate polish is required, I put the shaped pieces in a bath of collodion thinned greatly with alcohol and ether, the latter in largest proportion, to which I add per gallon one-eighth of an ounce of castor oil or glycerine, or one-half that quantity of each. Let the pieces dry for at least two hours, and rub with chamois, very fine felt or material for like use.

Eleventh. When skimmed milk is not of easy access, the ordinary pot cheese made without, or the skimmed milk cheese with, rennet may be substituted and treated as above, except that the amount of caustic soda in the handling of the first is to be trebled and in that of the second quadrupled; or borax may be used in place of caustic soda. The amount of water for dissolving the cheese will be about four times its volume. Common salt is then to be added to this solution. It is not, however, to be cooled below 80° Fah. before the fat can be skimmed or drawn off.

Twelfth. When a thin sheet of the more delicately colored and costly material is designed for any structure, some of the less expensive incorporated with any of the above admixtures of silica with hydraulic cement, to give it solidity and strength, or pulp of any kind, where weight is objectionable, may be used as a backing to the thin sheet, and so applied before the final pressure in the mould or die.

Having fully described my invention, what I claim is:

1. The combination of skim milk with salt, caustic soda, terra-alba, hydrochloric, nitric and sulphuric acids with coloring matter, as above described and set forth.

2. The combination of skim milk with caustic soda, alum, glycerine, ammonia, chloride of barium and sulphuric acid with or without silica and coloring matter, as above described and set forth.

3. The combination of pot cheese with borax, hydrochloric, nitric and sulphuric acids, silicate of sodium, terra-alba and coloring matter, as above described and set forth.

4. The combination of skim milk cheese with caustic soda, alum, terra-alba, tannin and silica, as above described and set forth.

THE TELECTROSCOPE.

By LEON LE PONTOIS.*

I DESIGNATE by this name an apparatus having for its object the transmission of pictures or views of moving or stationary objects at great distances, and as I use electricity for the purpose of obtaining this result, I call this apparatus a telectroscope.

First let me say that by the transmission of pictures to great distances I do not mean the graphic transmission of sketches or writing as done, for instance, by the very ingenious invention of Prof. Elisha Gray, namely, the telautograph.

I intend to describe to you to-night the general outline of an apparatus that I have conceived for the purpose of seeing over as great distances as we hear by the long distance telephone.

There is, to a certain extent, an analogy in the mode of propagation of light and sound, therefore it seems rational to transmit the light rays over as great distances as we transmit the sound waves, by converting at a transmitting apparatus the rays of light into proportional electric undulations and reconverting at the receiving apparatus the electric undulations into rays of light of proportional intensity.

But the analogy between the telephone and the telectroscope is not so close as it seems to be. Sonorous vibrations affect our nerves of hearing by differences in the number of their vibrations per second, their loudness or their character. We can easily detect a certain sound among other separate sounds, and even give a name to their harmonious groupment (what the musicians call a chord), because each sound or its harmonies vibrates one of our nerves of hearing and only this one.

Vision is the sensation produced on the nerves dispersed all around the retina by the rhythmic motion called light.

Each of the nerves can indistinctly vibrate for the different light radiations known as colors, and we have an exact idea of them because they differ one from the other by the number of vibrations per second.

We see an object when it produces light by itself or reflects the radiations of another source of light, and we have a notion of its structure because from each point of its surface starts a ray of light affecting by its color and its relative intensity one of the nerves of the retina and only one.

Another object will affect this same nerve differently and will communicate to the cerebral matter a different impression, while on the contrary each of the nerves of hearing, similar to a resonator, always vibrates for the same sound and thus always transmits to the cerebral matter the same impression. This essential difference in the mechanism of vision and audition renders the realization of an apparatus to see at long distances more difficult than the realization in an apparatus to speak at long distance, because while we distinguish one object from another by differences in the number of vibrations and the relative position of its radiations, we differentiate one sound from another merely by the number of their vibrations per second.

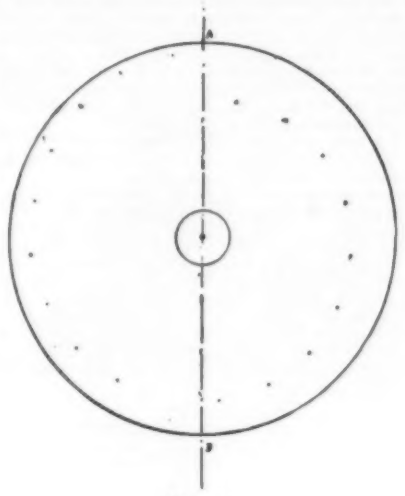


FIG. 1.

However, a few attempts have been made in this fascinating field, and among them I must recall to your minds the telephote of Prof. Bidwell. This apparatus for producing pictures or writing at a distance is an application of a property of selenium in combination with the chemical telegraph. In this telegraph a colored mark is made at a distance when current is transmitted, and *fac-simile* of the original may be produced by a series of dots and lines. A continuous current of greatly varied intensity would result in similar variations in intensity, and such a variable current is producible by changes in the resistance which may be produced by light acting upon selenium.

Mr. Shelford Bidwell made an apparatus for this purpose. The transmitter is a dark box, one end containing a selenium cell forming part of the line circuit and facing a small hole at the other end; the box is mounted on an axis so as to move up and down, each upward motion corresponding to one rotation of the receiving cylinder, and so to one line on the drawing produced. The box also moves sideways at each stroke, to correspond to the distance of the lines apart. The face of the box corresponds to the screen of a magic lantern and the picture to be transmitted is thrown upon it continuously, so that the pin hole is, so to speak, an eye by which the selenium cell looks the picture over and receives impressions from each part successively as it traverses over the space filled by the picture. When a dark line is thrown on the hole the resistance increases, while a white portion reduces it. The transmitter is really a differential instrument. It receives the line current at one terminal and that of an opposed local battery at the other, the line being also connected to the other pole of the battery and resisistance so arranged that the local battery acts and makes a mark whenever a dark line is to be produced, and thus the traveling style produces either no action at all or colored lines varying in depth of tone in correspondence with the amount of light falling upon the selenium cell from the distant transmitting illuminated picture.

It is a well-known fact that the impressions made on the retina by the rays of light emitted or reflected by a body do not disappear instantaneously if an opaque body is suddenly placed between the eyes and the luminous body. This persistence of vision can be explained by the fact that, vision being caused by vibratory movements imparted to the optic nerves by the rays of light, on account of inertia these vibrations have a tendency to persist a short time after the cause that has originated them disappears.

On account of the same principle of inertia, the impressions do not take place on the retina as soon as the light rays strike it. It takes a certain time before the optical nerves vibrate synchronously with the rays of light. That is why we cannot see a body when it passes very rapidly before our eyes, and we have in optics the retardation of vision as we have in electricity the capacity and the self-induction. That is why we can see distinctly and continuously an object placed on the rear of a fly wheel turning very fast, though the spokes cover successively the different points of its surface, and it does not matter whether the object has a movement of its own or not, provided, of course, that the speed of this movement does not exceed a certain limit. Quite a number of optical instruments—rather toys—have been constructed on this principle: the taumatrope, the phenakistiscope, the kaleidoscope, so universally known that they do not need to be described.

The only difference existing between this last instrument and the Edison kinetograph lies in the fact that the pictures that in the phenakistiscope represent a different position of a body while moving are drawn by guess (so to speak), while in the Edison kinetograph they really represent a different phase of the movement, because each of them is a photograph taken in the one ninety-ninth part of a second, showing a different position occupied by a moving body. Forty of these pictures are taken in a second, and their rapid succession before the retina gives a perfect illusion of the motion.

The impression is striking, and one would vow that the picture is really moving. Consequently the kinetograph stores and reproduces the impression made on the retina by moving objects as the phonograph stores and reproduces the human voice.

I have spoken at some length about the persistence of vision because the telectroscope is partially based on this fact.

The transmitting apparatus is made of a dark box provided with lenses like a camera. At the focus, where the sensitive plate is ordinarily exposed to the action of light, is placed an open disk made of very thin and light material, mounted on a shaft. This disk is shown in part in Fig. 2. Pinholes, about $\frac{1}{100}$ of an inch in diameter, are perforated near the periphery on concentric arcs of circles, the difference between the radius of two successive arcs being $\frac{1}{100}$ inch, while the distance between two holes is equal to the width of the image painted by the rays of light on the superior part of the disk.

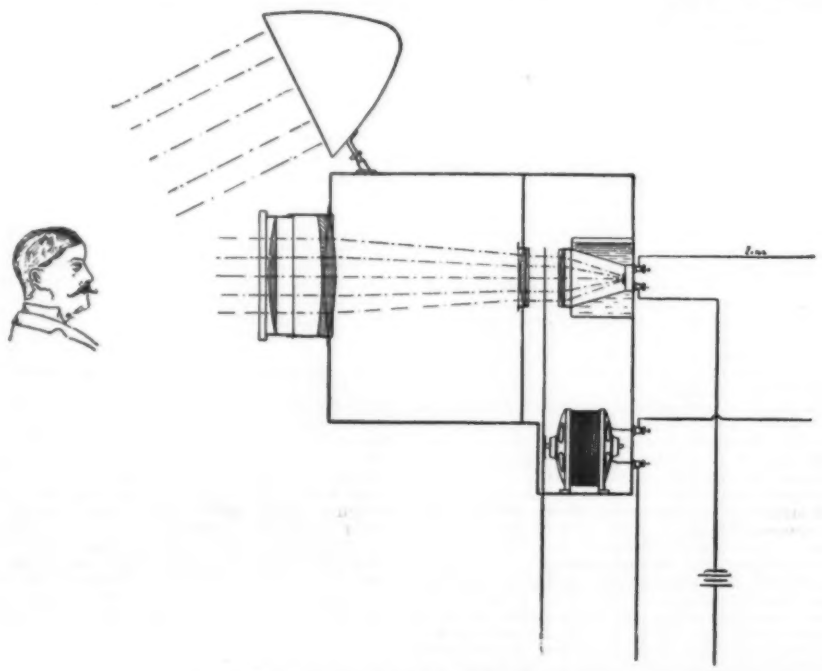


FIG. 2.—SEEING BY ELECTRICITY.

The number of the perforations is such that the total of their diameter is equal to the height of the image. The holes being thus dispersed on the surface of the disk, and the disk revolving, the perforations traverse the surface of the picture according to different concentric lines and the rays of light pass successively through the disk when the perforations are moving past them.

The conversion of the rays of light into electric currents of proportional intensity is effected by a special selenium cell of an extreme sensitiveness acting by the influence of the heated light.

There has been considerable debate as to whether the changes in the resistance of the selenium are due to the light or to the heat. In fact, I believe as the re

* Read before the Pittsburg Electric Club.—*Electricity.*

sult of my own experiments that in most of the cases the increase in the intensity of the current is due to the combined action of both.

Send a beam of light through a tube containing a solution absorbing the hot rays, alum for instance, before directing it upon the selenium, and let us suppose that the beam of light falling upon the selenium has exactly the same temperature as the selenium.

The resistance decreases in a certain value or seems to decrease—but how can we admit that in the conditions of the experience the light has modified the molecular structure of the selenium? In fact, the change of resistance is apparent, and the current flowing through the circuit has a greater intensity, not on account of a diminution in the resistance of the selenium, but because the undulatory movement called light has imparted an excess of speed to the undulatory movement called electricity.

I have demonstrated that in the mechanical theory of electricity the E. M. F. expresses the speed of the undulatory movement called current.

Consequently, the excess of speed imparted by the light to the vibrating atoms of the selenium will cause an increase in the E. M. F. of the battery and therefore in the current.

I am convinced that even if a galvanometer sensitive enough could be constructed, one could possibly detect the presence of a current merely due to the action of light falling upon the selenium.

If now the hot lights act directly upon the selenium, the variations in strength of the current are much greater, but the action of heat differs from the action of light.

While the light sets up, we might say, an additional E. M. F., heat causes really a diminution of resistance due to the fact that selenium being a crystalline body, the contact between its surface and the electrode on which it is deposited is far from being perfect, and is rather a microphonic contact that can be modified by expansion or contraction.

It does not seem at first possible that such modifications can take place instantaneously, but we have learned by recent discoveries how great is the sensitiveness of matter to the smallest variations in the streams of radiant energy. The changes of temperature are attended with great molecular changes, modifications of structure and properties, which occur with a rapidity comparable only to the speed of light.

The reason of this lies in the fact that each molecule of matter is the center of action of many forces, a center modified instantaneously by any change of relation among those forces.

As a consequence of this, a beam of obscure heat of variable intensity must modify the resistance of the selenium, and in fact it does so, but the action is more complete if the falling beam of heat is luminous, because the heated light penetrates more deeply through the selenium, whose molecules are probably more diathermanous for the luminous rays than for the obscure rays.

Consequently the variation that will occur in the resistance of the selenium cell, upon which falls a beam of heated light, will be greatly increased if the difference between the temperatures of the selenium and the rays of light is as great as possible.

In order to obtain this result I direct the light of a projector located on the top of the apparatus toward the object whose picture is to be transmitted to a distance, and I use preferably a source of light giving very hot rays—calcium light for instance; thus the temperature of the light rays reflected by the object and directed by the lenses on the surface of the selenium is higher, and therefore the effect is increased, but in some cases it is not possible to raise the temperature of the illuminating rays above a certain limit. To remedy this inconvenience I cool the selenium cell by placing it inside a conical cavity forming part of a receptacle containing a cooling mixture; the cone is closed at its base by a lens facing the disk and directed at its focus where the selenium cell is exposed, and the rays of light pass through the perforations of the disk.

By this disposition the difference in the temperature of the heated light rays and the selenium is as great as possible, and consequently the variation of the current is a maximum.

The selenium cell is made of strips of tinsel foil separated by narrow strips of dry paper—the pile is held by a clamp and its face covered by a coating of selenium, which in turn is covered by a very thin coating of lampblack.

With the apparatus thus constructed, it can be easily understood that if the disk is caused to revolve, each of the rays of light forming the picture will successively set in the line currents of varying strength. These currents act at the receiving apparatus upon a microphonic relay acting on the telephone receiver, shown in Fig. 3, modified by the addition of a narrow chamber placed between the disk and a cover hermetically closing the telephone.

One of the chambers is full of oxygen, brought in by a pipe, and the other is full of hydrogen.

On the top of the covers is tubing properly adjusted and provided with regulating valves.

The two gases are brought under pressure near the surface of a cylinder of carbonate of calcium.

The variations in the strength of the current of the microphonic relay cause pulsation of the diaphragms. But those pulsations, even if they are of a molecular nature, impart to the molecules of the gas an excess of speed, causing proportional variations in the intensity of the oxyhydrogen light. Lens and a reflector concentrate the light on a ground glass or screen after having previously passed by one of the perforations of a disk absolutely similar to the disk placed in the transmitting apparatus.

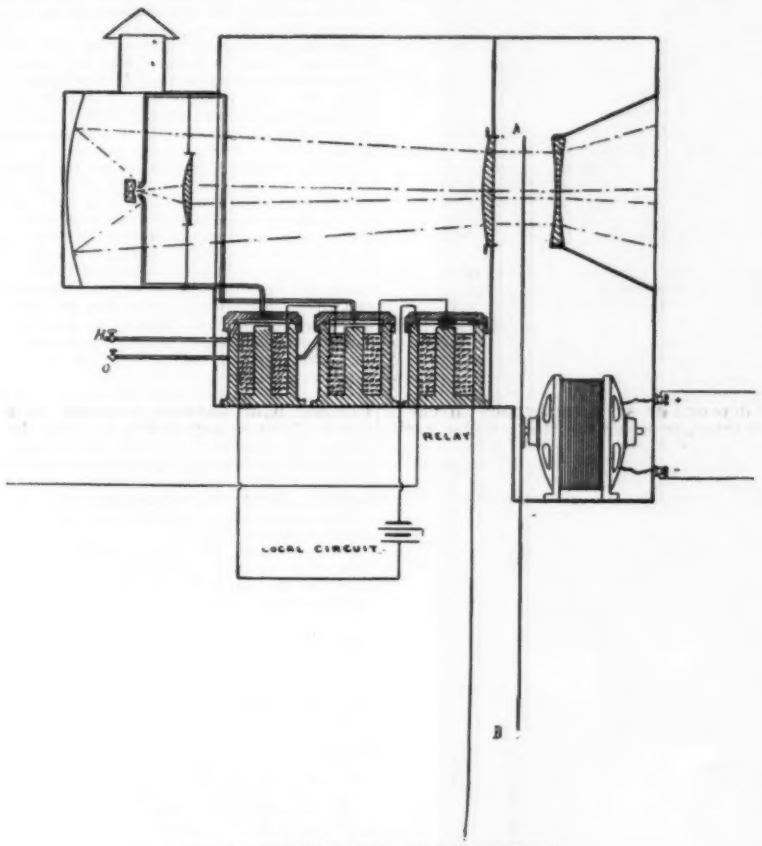


FIG. 3.—SEEING BY ELECTRICITY.

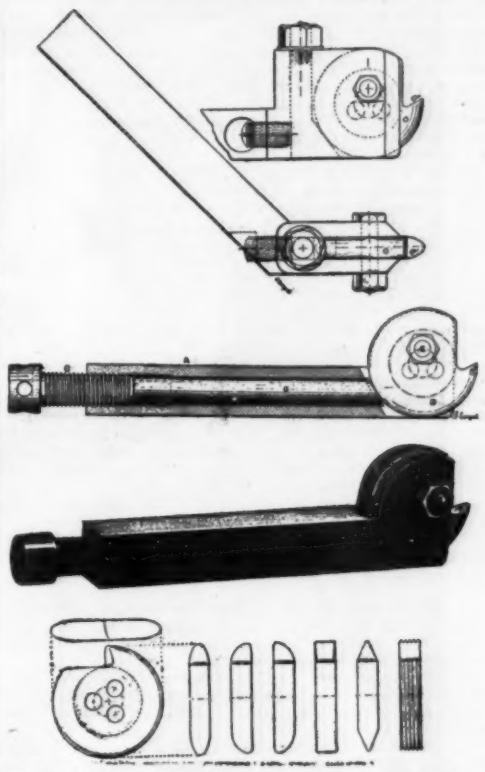
Then, according to the position occupied by the perforation on the surface of the disk, the beam of light passing by this point makes a more or less luminous point some place on the depolished glass.

But as the two disks are revolved synchronously by the two pulsating current motors, whose pulsations are controlled and even created by the vibrations of a tuning fork, when the light of the receiver passes through a certain perforation of the receiving disk one of the rays of light emitted by the object passes by the same perforation of the transmitting disk. If the disk turn slowly, each ray of light emitted by the different points of the object placed in the field of the transmitting apparatus is converted into an electric current of proportional intensity, which current is reconverted at the receiving apparatus into a beam of light of proportional intensity, and if a sensitive plate were substituted for the ground glass, a picture would be taken of the object placed in view of the transmitter after a complete revolution of the disk. But if the disks are revolved at a rate of ten revolutions per second, each point of the depolished glass is more or less luminous or dark ten times a second, and on account of the persistence of vision the retina is not affected by the successive disappearance of the points, which taken together reproduce exactly the object placed in view of the transmitter.

It does not matter even if this object moves or not, because the image of the receiver is constantly modified by its movements.

IMPROVEMENTS IN TOOL HOLDERS AND CUTTING TOOLS.

MR. THOMAS BLEARS, of Freme Street, Chorlton-on-Medlock, Manchester, has designed several improvements in turning tools and tool holders, which we illustrate in the accompanying drawings from the *Engineer*. It will be seen that the turning or planing tool consists of a circular disk, the cutting edge being formed by means of a notch or recess in the circumference, and the disk is rotated on a pin or bolt passed through it at a position out of its center. The tool holder carries the cutting tool between two jaws, where it is held in position for its work by a thrust pin acting on a part of its circumference at one side of the center, and in the disk cutting tool three holes are arranged round the center to enable the tool to be completely rotated by the thrust pin in order to utilize the whole circumference for cutting. One main object in designing this improved tool and holder has been to afford greater facilities for the economical use of tool steel of all kinds, and it varies from other similar appliances in that by the method in which the cutting disk is supported between the jaws, it is carried eccentrically, and by means of the separate holes its position can be gradually varied so that the whole of the circumference of the cutter can be utilized—the position of the cutting edge being gradually brought forward as it is worn down by use and regrinding. Another advantage of these eccentric holes is that the cutter can be raised or lowered to suit the varying centers of different lathes, and this arrangement gives it practically a range of from 8 in. to 15 in., while another and equally important advantage gained by the eccentric position in which the cutter is supported is that it cannot possibly slip from its work, the tool being held rigidly in position below the point of suspension by the thrust pin, actuated by a forcing screw, which, as already indicated, also regulates the position of the cutter in relation to its work according to the lathe, or as it is ground for sharpening. The introduction of a thrust pin for holding the cutter in position also possesses the advantage that it dispenses altogether with any packing of the tool holder in the slide rest, all that is necessary being simply to bolt down the tool holder, and after regulating the cutter



BLEARS' CIRCULAR CUTTERS AND TOOL HOLDERS.

by means of the forcing screw, the only further operation required is the tightening of the bolt support between the jaws of the tool holder. This arrangement of holder also enables two separate tools to be used simultaneously, one roughing and the other finishing at the same operation, or in heavy work two roughing tools may be used at the same time, one, of course, taking the cut slightly in advance of the other. The illustrations show the tool holder with a square stem, but when used for chasing or screw-cutting purposes the stems of the holders are made round, so that they can be canted to suit the rake of the screw to be cut. The holders can also be made with straight stems as shown, or at any angle to meet the requirements of special work, but they are so arranged that the cutters in all cases remain straight, the jaws supporting them being placed at the angle required. On the face of each cutter a fine grinding line is circumscribed as a guide for the workman in grinding up the tool to prevent it being cut away below a certain point, and the tool can be kept in use until the whole of the surface outside this fine line has been completely ground away, leaving a small disk simply diminished in size by the amount of material which has been ground away.

Among other special features that the inventor claims for these new tools is that, in addition to the economical use of the expensive tool steels, no smithing or tempering of the tools is required, and that less grinding is necessary. Test tool holders and tools made on the above design have been worked for several months at one or two engineering shops in the district, and we are informed that they have given complete satisfaction for turning, planing and shaping purposes, and have fully carried out the special advantages which Mr. Blears claims for them. Our illustrations show a plain and sectional elevation of the tool holder and cutting tool, two sections of an angle tool holder and a group of the special cutters, which, of course, can be designed to meet all varying requirements of work.

THE COCKATOOS.

THE cockatoos, in the order of the parrots, form a distinctly characterized family, both as regards the structure of the principal parts of the skeleton and mode of coloration of the plumage and their geographical distribution. They are birds of a robust and even somewhat gross form, with plumage of a uniform color or of slightly varied tints, that inhabit Australia, New Guinea, Timor, the Solomon Islands, the Moluccas, the Philippines, Celebes, and a few countries of less importance.

The cockatoos, the only members of the family that we intend to occupy ourselves with at present, constitute a clearly defined genus, for they are distinguished from other members of the family by their smaller size, their thicker-set body, their less powerful bill, their shorter tail, and their plumage, which is of brighter color and more agreeable to the eye. Although they are always less richly plumed than the Australian parrots and the avas of the New World, the cockatoos can, in our opinion, sustain with advantage a comparison with these brightly colored parrots, for their costume, especially during the life of the bird, exhibits shades of an exquisite delicacy and brilliancy. Light rose, vermilion red, sulphur yellow or lemon yellow set off the snowy whiteness of their plumage or color it with a light reflection. At other times it is a delicate rose color that harmonizes admirably with pearl gray, or, again, a scarlet that trenches upon black or iron gray.

THE COCKATOOS OF THE PARIS GARDEN OF PLANTS.

In certain cockatoos the head is provided with large plumes that are capable of expanding into an aureola. In others it is surmounted with an elegant tuft, whose narrow curved feathers recede from each other when the bird is irritated. Finally, in others it is ornamented with an egret of decompound feathers of an original effect.

These differences of livery, in connection with modifications in the form of the bill, in the proportions of the various parts of the body and in the aspect of the face, permit of recognizing the species of cockatoos without much trouble. Thus, in the helmeted cockatoo (*Cacatua galerita*), which is found in the northwest and south of Australia, the plumage is of a slightly sulphury white. The head is provided with a beautiful tuft of a light yellow, the feathers of which are as if goffered and gracefully raised at the extremity, the bill and the feet are black sprinkled with gray and the eyes are surrounded by a naked circle of a whitish or livid shade. This naked circle is, on the contrary, white in the triton cockatoo (*Cacatua triton*) of New Guinea and the neighboring islands. In the sulphury cockatoo (*Cacatua sulfurea*), a species of smaller size met with principally in the Celebes, the yellow color is marked and forms two spots near the ears. It turns to orange upon the occipital feathers of the citrine-crested cockatoo (*C. citrino-cristata*), which inhabits the island of Sumba and perhaps also Timor-Lant. Finally, without changing form, the tuft is colored red at the base, yellow in the center, and remains white at the extremity in Leadbeater's cockatoo (*C. Leadbeateri*), sometimes called by bird dealers by the entirely improper name of Inca cockatoo. Far from inhabiting Peru, as this common name might lead one to suppose, its country is the Australian continent.

On the contrary, in the white cockatoo (*C. alba*) and the crested cockatoo, the feathers of the posterior region remain short and rounded and are capable of expanding into a diadem. The same is the case with the ophthalmic cockatoo (*C. ophthalmica*), thus named because its eye is surrounded by a sky-blue naked circle. In this species the plumage is white slightly tinged with yellow, while it is pure white in the crested cockatoo, and white washed with red in the Molucca cockatoo (*C. Moluccensis*), a bird of large size inhabiting the islands of Ceram and Amboyna.

In their smaller size and their bill covered at the base with a feathered membrance, the naked-eyed cockatoo (*C. gymnopis*) of Southern Australia and the blood-colored cockatoo (*C. sanguinens*) of Northern and Eastern Australia differ from the cockatoo of the Moluccas, while, at the same time, they are distinguished from each other by the form of the naked space that surrounds the eye, and which is rounded in the blood-colored cockatoo and elliptical in the other species.

In these birds, besides, the region included between the eye and the bill is deeply tinted with red, while it remains white in Ducorps' cockatoo (*C. Ducorpsi*), discovered on one of the Solomon Islands by the naturalists of the Astrolabe expedition. In this species, the lower parts of the body are of an almost immaculate white, but in the small cockatoo of the Philippines (*C. Philippinarum*) the sub-caudal feathers are of a vermilion red, and in the rose-colored cockatoo of Australia (*C. rosea*) a carmine tint encroaches upon the lower part of the body, ascends upon the cheeks and reddens the crest, while the back and wings are of a pearl gray color.

By its costume the rose-colored cockatoo notably differs from the ordinary cockatoos, but not as much, however, as the red-crested cockatoo (*C. galeata*), whose head and body are covered with black feathers bordered with white and distinctly detached like scales, and the head of which is surmounted by a tuft of finely dissected scarlet feathers. By these characters, this species, which is found both in Australia and Tasmania, establishes the transition between the cockatoos and the calyptorhynchi, and has sometimes been placed in a particular genus called *Callocephalon*.

After we have added that the dwarf cockatoo (*C. nana*) of Timor is but a diminutive of the helmeted cockatoo, and that Goffin's cockatoo of Tenimber Island is merely a reduction of the blood-colored cockatoo, while the nasic cockatoo (*C. nasica*) of New South Wales and Central and Western Australia offer, on the contrary, a perfectly distinct type, owing to their hooked and prominent upper mandible, we shall have passed in review all the species of the genus *Cacatua*, in summarizing their distinctive characters. It remains for us to say a few words as to the habits of these magnificent birds.

The cockatoos do not ascend to a great altitude upon the mountains, and do not seek the shade of thick forests. They are especially fond of plains strewed with clusters of trees. Outside the season of nesting, they form numerous flocks after the manner of the Amazonian parrots, and, like the latter, seek at nightfall the summit of the highest trees, making a great noise.

At dawn, with new cries, they take flight in order to alight upon a field newly sown or covered with a rich harvest, or upon a fruit orchard in full bearing. Here they give themselves up to true orgies, and interrupt their festivities only at the hottest hours of the day, during which they take a siesta, squatting in the foliage.

Owing to their ample wings provided with strong feathers, their flight is easy and well sustained, and, like all the parrots, they climb with much dexterity. Upon the ground, on the contrary, their gait is singularly awkward and uncertain. They stumble forward, hop heavily, and look about for a point of support to which they can fasten themselves with their bills. As soon as they find themselves within reach of a tree, they are immediately free from embarrassment. They seize the bark firmly between their mandibles, and, aiding themselves alternately with their bill and feet, they ascend with incredible rapidity up to the highest branches.

Certain cockatoos build their nests in the trunks of trees, others in the fissures of rocks upon the banks of rivers. Their eggs, numbering two or three at the most, are smooth and of an immaculate white. The young are at first covered with a white down, but soon, after the first moulting, take on the plumage of the adults. They soon accompany their parents in their daily excursions, and even in more distant voyages made in quest of food.

By reason of the great ravages that they cause in fields and gardens, the cockatoos are relentlessly pursued by the English colonists established in the fertile plains of Australia. In the interior of this same continent, they are likewise the object of a very active warfare on the part of the natives, who destroy entire flocks of them by means of the boomerang, their favorite weapon. The Papuas seek the feathers of these birds, which the warriors stick in their frizzly hair as soon as they have killed an enemy in war.

Finally, in New Holland, as in New Guinea, the Moluccas and the Philippines, many cockatoos are captured alive in order to be shipped to Europe, where they are sold at prices that naturally vary according to the beauty or rarity of the specimen.

The cockatoos endure captivity very well, and, with a little care, can be preserved for a long time in our climate. Brehm mentions a specimen that lived in Europe for seventy years. Various cockatoos, and especially the helmeted cockatoo, have laid eggs at the Garden of Plants, of Paris, and at other zoological gardens. Mr. E. Dulitz has succeeded in raising three successive generations of the species that we have just mentioned. These birds, which are not very particular as to the choice of their food, eat indifferently hemp seed, boiled rice, Indian corn, dry bread, apples, cherries, grapes, nuts, potatoes, and even, according to Mr. Dulitz, radishes and cabbage. A simple and frugal diet is what is best suited to them, and care must be taken not to offer them dainties in excess or too fatty food, for this would render them obese and predispose them to apoplexy. Among the maladies to which they are subject, one of the most frequent is an irritation of the skin that drives them to pluck out their feathers, but, according to Mr. Megnin, this cutaneous affection can be combated very well by giving the subjects that are afflicted with it small pieces of meat and making them drink water that is slightly arsenical.

If the cockatoos had not so sharp and disagreeable a voice, they might be recommended as house birds. They are, in fact, tamer and less wily than the avas and the amazons and quickly become attached to their owners. Provided attention is paid to them and they are spoken to when they are fed, the cockatoos, which reproduce of themselves the mewing of the cat, become used to speaking a large number of words. One of those that they repeat most easily is *cackatoo*. According to Mr. Finsch, this word, which has given the birds their name, and to which Brisson has given the Latin form *cacatua*, is not, as generally supposed; a simple onomatopœia, the natural cry of the bird living in a wild state, but is a Malay word signifying pincers. In fact, we read in Klein's "System of Nature" that one of the species mentioned above is called *cacatucha* by the natives of the Moluccas.

The cockatoos manifest their hostility toward dogs and cats by crying and flapping their wings. They receive in the same way and try to bite those who have done them an injury or who are accustomed to tease

them, for they are of a spiteful disposition. In return they show their satisfaction at the sight of their friends by uttering glad cries, by lifting their heads and by stretching out their necks to have them scratched. These birds, in fact, seem to experience an extreme pleasure upon feeling a hand smooth their feathers or tickle their epidermis. Like cats, they then assume a pleased expression, close their eyes and end by falling into a hypnotic slumber. Mr. Von Martins has observed the same thing in a scops of Japan and in a mainate of Java. All these birds, cockatoos, owl, and mainate, were hypnotized by a dozen frictions operated upon the head. They then allowed themselves to be laid upon a table and remained motionless, the limbs flaccid, and kept any position that the operator saw fit to give them. But this cataleptic state did not last long. In a few instants the bird regained its senses and got upon its legs again. The sleep was still abrupter when a slight blow was given the table. The facility with which the cockatoos allow themselves to be put to sleep and their aptitude for receiving a certain education have caused them to be selected as subjects by exhibitors of learned birds.

In terminating this article we must not forget to remark that the geographical distribution of the cockatoos presents peculiarities worthy of interest and which are not in favor of the theory put forth by an English naturalist, Mr. Tristram, and according to which the majority of the present ornithological families had their origin in the vicinity of the north pole. The cockatoos, in fact, scarcely cross the limits of the region which Dr. Trouessart, in his zoological geography, designates by the name of the *Australian region*, and they are connected with no boreal type. This Australian region corresponds to Dr. Reichenow's *austral zone*, which is situated to the south of a *Malaisian region* which is itself situated between an *Ethiopian region* and a *South American region*. Now, just as the Ethiopian, austral, and South American regions possess, each of them, representatives of the three great families of long-tailed parrots (Paleornithides, Platycercides, and Conurides), so too do they each possess representatives of one of the three great families of short-tailed parrots (Psittacides, Cacatuides, and Chrysotides or Amazones).

An analogous observation may be made for the runners or brevipennes, whose three principal types, the ostriches, casoaries, and nandoos, are distributed between three regions, Africa, Australia and Papuasia, and South America.—*La Nature.*

AMONG THE CLIFF DWELLERS.

By CLEMENT L. WEBSTER.

IN the August number of the *Naturalist*, for 1891, the writer, in an article entited "Preliminary Notes on the Archæology of Southwestern New Mexico," alluded to, for the first time, the most important discovery of a cliff dweller mummy, made by him in a cliff dwelling of that region; and promised to, later on, give a more detailed account of the discovery.

The present sketch then may be considered as a partial redemption of the promise then made.

The Mogollon Mountains of Southwestern New Mexico are one of the most rugged and broken of the great Rocky Mountain system.

This region abounds in deep and vast canyons, sometimes so profound as to almost exclude the light of day. This region is also deeply cut and scored by the channels of the headweaters of the Rio Gila, known as the east, west and middle branches.

At no other place in this great system of mountains is there presented so abundant and diversified scenes of wild and romantic beauty.

A strange charm surrounds this region; and there is here presented a remarkably rich field for the study and investigations of the archæologist.

For almost everywhere here in the natural caves, in and at the base of the almost innumerable cliffs, are found the former abodes of the cliff dwellers. Some of these dwellings are solitary, and only large enough to accommodate one or two persons; while others occupy a series of large connected caves, where are sometimes found as many as twenty-five or thirty beautifully preserved rooms or dwellings. The writer spent some time in this region making explorations in these ancient ruins, sketching and drawing; and here obtained a large and exceedingly valuable collection of specimens.

Extending out from the west branch of the Gila, about three and one-half miles above its confluence with the main Gila, is one of the most beautiful, wild, and romantic canyons possible to be found.

The average width of this canyon is perhaps 35 or 40 ft., while towering cliffs rise perpendicularly on either side to a height of from 200 to 300 ft. by estimate.

Through this wild glen there rushes, during the rainy season, a small stream of pure water, clear as crystal. The lower nearly one-half of these great cliffs is composed of a hard, dark colored basalt, upon which the elements have made but slight impression; and overlying them is a vast stratum of buff colored conglomerate, such as occupies such extensive areas in Southwestern New Mexico, portions of Arizona, and California.

Here the lower portion of this vast stratum of conglomerate has been worn away by the slow action of the elements, leaving a narrow projecting shelf of basalt extending along horizontally for some distance.

In the base of this conglomerate nature has formed numerous large connected caves.

These caves the ancient cliff dwellers had taken possession of, and in them reared their strange dwellings.

Here may be seen upward of twenty-eight rooms, of different sizes, shapes, and designs, which, taken together, form the most interesting group of these dwellings which the writer has ever seen.

As the object of this paper is mainly to deal with the discovery of the mummy already already alluded to, a detailed description of these and other cliff dwellings, etc., will be deferred to a future report.

One of the questions regarding the cliff dwellers is that pertaining to the dispositions made of the remains of their dead.

But very few facts have been obtained thus far which shed much light upon this question.

There have been discoveries made, however, which demonstrate that in the matter of disposing of the dead, departures from the general custom, whatever that may have been, were occasionally practiced. One of these exceptional cases was brought to light in the discovery of the mummy which forms the subject of this paper.

This mummy was discovered in one of the rooms of the large collection of cliff dwellings just described, and had been carefully placed in an excavation made in the floor, on the side and slightly under the partition wall. The wall here, as well as elsewhere, rested upon the debris which previously collected in the cave. Every portion of the body, including the nails, hair, and teeth, was perfectly preserved.

The preservation of this body was due to the great dryness of the atmosphere of the country and the chemical elements of the soil, etc., in which it was entombed. The mummy was small, being that of a child apparently about seven years of age; although inferior in size to that of a child of the same age with us.

It had been carefully and completely wrapped in two large pieces of coarsely woven cloth of different textures, made from the fibers of the "Spanish dagger"—which was used so extensively by the cliff dwellers for this and other purposes—and then again as carefully wrapped in a large and nicely woven mat of bear grass.

After this it was bound with cords onto a small and curiously shaped board of cotton wood, the cords crossing the body and passing through small circular holes made in each corner of the board.

The board had apparently been fashioned with a stone ax, and afterward finished by being rubbed with some instrument.

The hair on the head of the mummy was of a beautiful dark brown color, and of a soft and silky texture. The arms were drawn up near to the sides of the head, and hands clinched, and the legs also were somewhat drawn up.

This description is better illustrated by the plate, Figs. 1 and 2 (copied from a photograph), which represents the back and front views of this mummy.

At the feet is shown a portion of the mat which formed the outer covering, and the board to which it was bound.

There existed on the wall of one of the rooms, located a few feet from where the mummy was discovered, many strange and interesting characters, or picture writings of these ancient people, painted in the provincial red color.

Close by where the mummy was found was also discovered an ancient weaving room, of the greatest interest. In this were found portions of the ancient loom, woven fabrics, etc.

Near the mummy were discovered long braids of human hair identical in all respects with that of the mummy, save that it was much longer and of a coarser texture. In other rooms of this pueblo were found great quantities of corn cobs, husks, and kernels of corn, squash or pumpkin rinds, seeds, and stems, gourds, sandals, wearing apparel, basket and other woven work, pottery, stone mills, weapons, utensils, etc. Such a mass of evidence was secured, in connection with the discovery of the mummy, as to leave no doubt as to the genuineness of this relic. So far as the writer is aware, this is the only specimen of its kind of the cliff dwellers ever discovered.—*American Naturalist.*

FIG. 1.

FIG. 2.

MUMMIED CHILD FROM A CLIFF DWELLING.

THE USE OF POISONS AS FUNGICIDES AND INSECTICIDES.

By L. R. TAFT, Agricultural College, Michigan.

ALTHOUGH copper sulphate has been used for many years for the destruction of the smut spores of wheat and oats, it is only about ten years since it was first employed upon fruit and similar crops as a fungicide, and for fully one-half of this period it was only used in an experimental way.

Its effects have proved so beneficial, however, that the fruit growers of the State of Michigan alone will this year use several tons in combating the various diseases that infest their crops.

The amount in time and materials expended in the use of fungicides in the United States must then reach many thousands of dollars, and it is very desirable that as much light as possible be secured upon the time and number of the applications that are necessary to obtain the best results, as well as upon the mixtures that will be most effective and economical. It has been clearly shown by many experiments that, to be most effective, the applications must be made early in the season, before the disease has obtained a foothold; but, as the number of sprayings required to hold the disease in check will depend upon such conditions as character of crop, season, and location, and the prevalence of the disease, it is doubtful if anything more than a general rule can be given, and this must be modified to suit the conditions.

Experiments have demonstrated that very small amounts of the salts of copper will destroy the spores of fungi, and have shown that the original formulæ for most of the fungicides were deficient in water, or in other words, the mixtures were unnecessarily concentrated. Although, as now used, the strength has been greatly decreased, the limit has by no means been reached. The amount of copper sulphate in Bordeaux mixture has been reduced from sixteen to six pounds for twenty-two gallons of water, and the experiments of the writer tend to show that for many diseases one or two pounds are fully as beneficial.

Two or three years ago most writers recommended some form of ammoniacal solution of copper carbonate, but, after a thorough trial, most fruit growers have come to consider Bordeaux mixture preferable to any of the ammonia-containing mixtures. The ammonia solutions were commended as being cheaper and easier to apply; but, in fact, the Bordeaux mixture of the same strength is much less expensive; if properly strained, it is not likely to clog the pump or nozzles; it is less easily washed from the plants, and it is not only less likely to injure the foliage, but it allows the arsenites to be used at the same time, thus forming a combined fungicide and insecticide, and the lime also prevents all injury from the arsenic.

For these reasons the Bordeaux mixture is preferable, and its use should be commended.

This lime mixture covers the plants with a sort of whitewash, and, although this is one way objectionable, in another, from the consumers' standpoint at least, it is preferable to some of the clear solutions, which, although they contain fully as much poison, are not very noticeable upon the plants.

Fruits sprayed within a few days of the time of gathering would in one case not be salable, and in the other, although they might have upon their surface a sufficient amount of poison to produce injurious effects, would seem above suspicion.

The results obtained from spraying various fruits with a combined fungicide and insecticide in 1892 convinced the writer that too great care cannot be taken in the use of these poisons upon all crops, any exposed portions of which are edible, and that in no case should they be used within one month of the time of ripening, while an interval of six weeks to two months will be preferable. The fruits experimented upon were strawberries, raspberries, currants, gooseberries, cherries, and pears. The experiment was conducted in the same manner with all of the fruits, and when ripe they were analyzed and tested for arsenic and sulphate of copper. The spraying was done about as in ordinary practical work, except that it was rather more thorough the amount used being perhaps double that generally employed. Except that the raspberry and strawberry retained rather more of the poison, the results were quite similar, and those obtained with two of the fruits will answer for all.

Gooseberries sprayed June 18, 29, July 8 and 22, with Bordeaux mixture (copper sulphate, 2 pounds; lime, 1¼ pounds; water, 32 gallons) and London purple (1 pound to 200 gallons), using one-half gallon of the mixture to a very thick, full row two rods long. One pound of fruit gathered August 2 gave, on analysis, 0·0365 grain of arsenic and 0·355 grain of copper sulphate. In making the analysis, the fruit was first washed in ten per cent. hydrochloric acid, and the amounts of arsenic and copper sulplate thus abstracted were respectively 0·0208 grain and 0·208 grain, after which there remained of each 0·0162 grain and 0·147 grain.

Fruit from another row that had been sprayed in a similar manner, except that the Bordeaux mixture was made from the usual formula (copper sulphate, 6 pounds; lime, 4 pounds; water, 32 gallons), gave of arsenic 0·0723 grain, and of copper sulphate 0·62 grain, from one pound. In each case the last spraying was eleven days previous to the date of picking.

The pears were sprayed with the same mixture as the first lot of gooseberries, on June 15, July 7, 21, and August 7, and were gathered and analyzed September

6, or thirty days after the last application. The result from one pound of fruit gave, of arsenic 0·0089 grain and of copper sulphate 0·0745 grain.

The above analyses were made under the direction of Dr. R. C. Kedzie, chemist of the Michigan State Experiment Station.

Attention is called to the fact that only about one-fifth as much copper sulphate was found upon the pears thirty days after spraying as upon the gooseberries gathered eleven days after receiving the last application, also that with a weak solution as compared with a strong one, the amount both of copper and arsenic remaining upon the fruit was reduced in about the same ratio as the strength of the mixture used.

This certainly emphasizes the advice previously given (1) to use a solution as weak as will secure freedom from disease and (2) cease spraying with all poisons at least one month before the fruit ripens.—*Science.*

NOVEL THEORY OF THE MOON'S SURFACE.

To the Editor of the Scientific American:

Since completing a very fine 6 inch achromatic telescope, wholly by my own effort, from the very valuable instructions contained in the SUPPLEMENTS you sent me, I have been making a study of our nearest celestial neighbor, the moon.

I have been especially interested in the peculiar formations and figures on its surface, and have been unable to reconcile the existing theories concerning their cause to the results as they exist. I must deny that they were caused by volcanic action! How then were they caused?

Going back to a remote period in the history of world formation, we are led by science to believe that the solar system was once a nebulous mass, and in time this nebulous mass aggregated into the sun with the planets and satellites. This, of course, could only have been done by the particles of nebulous matter being attracted to the primary center, the sun, the secondary center, the planets, and the tertiary centers, the satellites of the planets.

Now it is a well established fact in physics that when inertia is overcome, heat is caused at the point of stoppage, and the greater the inertia overcome, the greater the heat produced. The sun, therefore, on account of its mass and attractive power, is the hottest of all the bodies of the system, because it attracted to itself and received the heat from the impact of the great bulk of the primary nebulous mass. The planets are hot also for the same reason, but not to the same degree in proportion to their size, but are or were heated to a degree corresponding to an arithmetical ratio regarding their respective masses; for the larger the mass the farther would they attract nebulous matter, and the greater the rate of movement and correspondingly greater impact and consequent heat produced by the falling nebulous matter.

The satellites were fairly hot, however, notwithstanding their small size, because they must have intercepted some of the nebulous matter attracted to the planets around which they revolve.

Now the moon's mass is scarcely one-eightieth that of the earth, and its primary heat regarded say as unity, then the original degree of heat of the earth must have exceeded it at least eighty times, and probably a great deal more.

Now the earth has gone through volcanic action and shrinkage, but has virtually no such mountains as the moon, although volcanic action must have been immensely greater on its surface than on the moon's face, on account of greater heat.

I maintain that the mountains and "craters" on the moon's face are directly the result of small bodies or planets falling into it when it was plastic from heat.

The outward circular ridge was due to the outward splash of plastic matter when the body struck, and the central peak was caused by a reactionary wave meeting in the center of the plain, thus throwing up a peak or "chimney." The smaller "craters," due to smaller bodies, have no central chimney and are deeper than the larger ones, because the reactionary wave of plastic matter was insufficient to meet in the center and throw up a peak.

An objection to this theory is found in the fact that the same face of the moon is always turned toward the earth, and that the small bodies could not get past the earth to strike that side of the moon turned toward us; but who will say that the moon never, in the long past, revolved differently from what it does now?

I send you some figures made on the surface of plaster of Paris while plastic by dropping marbles of different sizes into it, which will illustrate my theory. Viewed in a strong side light, their general resemblance to the lunar figures is striking.

The reason why the earth's surface presents virtually no such figures as are found on the moon was that, at the time these bodies must have fallen, the earth was too hot and too near fluid to leave any trace of such events.

These figures on the moon's face were probably caused by a comparatively late "shower" of falling bodies, after the moon had cooled to a certain extent.

Palmer, Neb., May 15, 1893. DR. MINNICH.

THE LOSS OF NITROGEN IN MANURES.

By A. MUNTZ and A. CH. GIRARD.

THE authors have determined the loss of nitrogen incurred in the stable, and find it to be for straw litter 68·6 per cent. of the nitrogen consumed by the animal, and for peat litter only 48·3 per cent. A comparison of the usefulness of a light soil in the stable, contrasted with straw litter, gave for the former a loss of 25·7 per cent. of nitrogen, while for the latter the loss amounted to 50·3 per cent. The ammonia is all the more easily absorbed, the more humic substances the soil contains.

For the retention of the ammonia in stables the use of copperas, gypsum, superphosphates, etc., has been recommended. The authors, however, found the losses of nitrogen for:

	Per cent.
Straw litter alone	46
Straw litter mixed with copperas	48
Straw litter mixed with gypsum	46

and they explain the inefficiency of the added chemicals by the alkalinity of the animal excreta, which has to be saturated before any ammonia can be retained.

An examination of dung of various domestic animals gave the following amounts of bases, measured by the quantity of SO_3 required to neutralize them:

		Grammes SO_3.
1 kilo. of horse dung	required	1·352
1 " cow dung	"	3·646
1 " sheep dung	"	4·200
1 " swine dung	"	2·022

In practice the use of straw litter mixed with peat and, perhaps, a soil rich in humic substances, seems to be the cheapest means of checking the enormous losses of ammonia occurring in stables.—*Comptes Rendus.*

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